An Evaluation of the Potential for Commercial Navigation to Additionally Contribute to Freight Transportation in the Tennessee River Basin

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Executive Summary

The Center for Transportation Research (CTR) was asked by the U. S. Army Corps of Engineers (USACE) and the Tennessee Department of Transportation (TDOT) to assist them in investigating the potential for water transportation to carry a greater share of the freight moving in the state. Tennessee is blessed with two tributary navigable streams that run over 500 miles inside the state and the Mississippi River that forms its western border. These water resources have available barge movement capacity that could help relieve highway capacity problems, especially as might occur once the economy rebounds from the recent business downturn.

To accomplish the requested help, CTR began with analysis of the historical record of the composition of freight and transport modes in Tennessee, relying on proprietary databases of fairly recent truck, rail, and barge movements (2007-2008). Narrowing the focus to potential barge diversions, this CTR study ultimately provides some answers to five pertinent questions:

(1) What commodities have potential for diversion to barge transportation?
(2) Would subsidies or incentives be necessary to accomplish diversions?
(3) Will Tennessee waterways be a conduit for container-on-barge traffic?
(4) What environmental and economic externalities might be associated with diversions?
(5) What policy alternatives might encourage diversions?

Using the Global Insight truck movement data, the historical record of Tennessee freight movements suggests some broadly defined diversion possibilities by identifying commodity groups with large quantities of goods moving within the state, in and out of its major metropolitan areas, or between waterway sub-regions. At the broadest level, these include mineral ores and products, petroleum or coal products, farm products, chemicals, primary metal products, and wood products. A large portion of truck traffic, especially in metropolitan areas, carries goods classified as warehouse and distribution commodities. Under current conditions, these goods probably have little potential for barge movement; for any waterway transport feasibility, it would seem to require, at minimum, significant investment in container-on-barge waterway facilities and equipment. CTR concludes that the greatest potential for diversion likely resides in the STCC2 group—nonmetallic ores and minerals, excluding fuels. This group includes broken stone commodities that are integral to TDOT and USACE construction activities. While most freight in Tennessee moves through the state, 84 percent of this ores and minerals group is inbound, outbound or local to the state, and may, therefore, be more amenable to any diversion efforts by the state. Eliminating the smaller movements, CTR finds 16.1 million tons of this minerals traffic moving between counties located on navigable waterways in and out of the state.

These data-derived findings are generally only suggestive, consisting of broad aggregations of either or both specific commodities and origin/destination locations. Refining the data analysis, an attempt is made to identify some more geographically and commodity specific movements between waterway-centered sub-regions. Narrowing the focus reveals the difficulty in locating sufficiently large movements of goods that are also sufficiently bulky and moved long enough distances to suggest that diverting to barge would be economically feasible, at least under current conditions.

There are, however, some significant possibilities that could be worth further exploration. Between waterway counties, the following are aggregated movements that appear most likely to contain potential diversion opportunities:

- metallic ores (1.4 million tons and 34 million one-way miles)
- Portland cement (264,000 tons and 5.4 million one-way miles)
- miscellaneous field crops (175,000 tons and 3.6 million one-way miles)
- primary iron or steel products (161,000 tons and 2.5 million one-way miles)

Some specific county-to-county movements (between at least one Tennessee waterway county and another county) that could suggest a possibility of diversion to barge include:

- metallic ores (Chatham, GA to Shelby, TN: 1.4 million tons and 34 million one-way miles)
- broken stone or riprap (Livingston, KY to Dyer, TN: 670,000 tons and 3.1 million one-way miles; Decatur, TN to Shelby, TN: 530,900 ton and 2.7 million one-way miles; White, AR to Shelby, TN: 212,400 tons and 1.0 million one-way miles)
- gravel or sand (Itawamba, MS to Shelby, TN: 280,000 tons and 1.3 million one-way miles)
- Portland cement (Mobile, AL to Shelby, TN: 263,500 tons and 5.4 million one-way miles)
- miscellaneous field crops (Loudon, TN to Chatham, GA: 175,300 tons and 3.6 million one-way miles)
- primary iron or steel products (Jefferson, AL to Pulaski, AR: 161,000 tons and 2.5 million one-way miles)

Once again, if COB were feasible, there are quite a few large and long movements of warehouse and distribution goods between waterway counties that could be considered.

Between county-aggregated waterway sub-regions (30-mile radius), leading candidates for diversion from the truck data movements include instances of the above commodities plus motor vehicle parts, asphalt coatings or felt, concrete products, mineral wool, miscellaneous plastics products, motor vehicle parts or accessories, processed nonmetal minerals, and primary forest materials. These movements are identified on maps in the report.

Diversion from rail to barge is not investigated in this study to the same extent as truck. However, it is possible some opportunities could exist. Rail traffic, estimated from the Waybill sample, totals 291.4 million tons for movements that had a Tennessee origin or destination (or both) or that moved through the state.[1] Coal accounts for 41% of the tons moved, and 61.2% was through traffic. Other major groups of commodities railed inside Tennessee include farm products (29.4 million tons); chemicals and allied products (21.1 million tons); food and kindred products (19.3 million tons); hazardous materials (17.0 million tons); FAK[2] (14.0 million tons); and pulp, paper, and allied products (12.6 million tons). Clearly, rail moves large quantities of some of the types of commodities that barge can handle. Of the four major Tennessee metropolitan counties on the water, Shelby

[1] Resulting from Rail Accounting Rule 11, the rail movement of goods and commodities are sometimes double counted--this happens where transloading occurs from one rail line to another. An example is the transloading of western coal in Shelby County Tennessee. This is discussed in that section of the paper.

[2] FAK represents a miscellaneous assortment of commodities shipped at one freight rate. The acronym means “Freight of All Kinds”.

carries, by far, the most tonnages in and out of the county. Disregarding FAK shipments, the five largest tonnages (ranked 1-largest to 5-smallest) in and out for the counties are:

	Davidson		Hamilton		Knox		Shelby	
	Out	In	Out	In	Out	In	Out	In
Chemicals	2	2	4	4	3		2	3
Farm products			3	1		2		2
Food and kindred products			2	2	4		1	1
Hazardous materials	3	5		3		4	4	
Lumber or wood products, exc. furniture							5	4
Mineral ores, exc. Fuel		4						
Mineral products		3	1		1	3		
Primary metal products				5	2	1		
Rubber or misc. plastic products	4							
Transportation equipment	5	1					3	5
Waste or scrap materials	1		5		5	5		

Any of these could be explored in more detail for diversion opportunities. Some large county-to-county movements are identified in the report that might bear further exploration for diversion opportunities.

Field research and interviews produced more specific diversion possibilities. CTR finds a likely potential for lessening truck traffic between Nashville and Clarksville, were one or more general commodities terminals to be constructed in the Clarksville area. Presently, there are significant quantities of some commodities being barged to terminals in Nashville and then trucked back to Clarksville. Construction of these terminals would reduce this truck traffic and lessen congestion on I24. Interviews with shippers in the area suggest that the potential traffic affected by the presence of a terminal or terminals in the area could be about 1.6 million tons.

For rail to barge diversions, a likely candidate is coal shipped by rail to TVA's Kingston Steam Plant. TVA is not ready to discuss this option, but CTR believes the Agency could benefit from the shift. Truck to barge diversion possibilities include USACE riprap (large quantities have been used to harden levees damaged by hurricane Katrina)[3], non-polishing stone used in pavement mixes, and, possibly, 300 mesh material used in the production of paint for highway striping. Because of the need for stone products in highway and levee construction, TDOT and the USACE were two of the most significant users of trucking services in the state in 2007.

With regard to incentives or subsidies, cost savings to TVA from shifting to barge delivery of coal at the Kingston Plant should provide its own incentive, although why it is currently insufficient to bring about the change is unknown. Unfortunately, for the trucked stone traffic, CTR concludes that the available Global Insight truck data do not provide sufficient information to adequately estimate the overall need for subsidies. CTR did, however, compare an existing truck rate with a hypothetical barge rate for one shipment referenced in the Global Insight file–266 thousand tons moving between

[3] Most likely this task has been completed.

Montgomery and Wilson Counties. In making this comparison, CTR estimates that the trucking cost from the quarries in downtown Clarksville to a destination near Lebanon on I40 (a distance of 75 miles) would be $11.54 per ton assuming that the trucks are loaded to 26 tons. Not knowing exactly the trucking destination (Global Insight only gives the county and road), CTR estimates the water rate to be $6.51. This rate assumes an eight barge tow to Old Hickory Lock and a four barge shuttle above the lock. The barge rate is thus significantly less than the rail rate (56 percent). If the commodity is non-polishing stone and the portable batch plant is near the dock, the total savings to the contractor of using barge transportation could have been $1.9 million.

With regard to the possibility of container-on-barge traffic, CTR finds that the likelihood of consistent and scheduled COB service in Tennessee, especially as might be related to Panama Canal expansion, is unlikely to occur. However, Tennessee could see some limited COB service, and Memphis could again see container traffic if the LIGTT terminal is constructed in New Orleans.

To investigate environmental and economic externalities associated with the diversions, CTR used its highway capacity model to examine the impacts, assuming a general commodities barge terminal in Clarksville had been available, such that one stone products movement between Montgomery County and Wilson County is taken off the highway. Assuming two percent traffic growth rate in all modes, the reduced truck traffic on the section of I24 between Clarksville and Nashville should result in benefits of about $344 million (present value over a 50 year period). From downtown Clarksville to Nashville, a reduction of one movement of stone products (266 thousand tons) is estimated to generate benefits valued at $84.7 million (present value over 50 years). And, since highway impacts are somewhat nonlinear, the shift of several movements to barge over the same stretch of roadbeds could significantly increase the total benefits of these modal shifts.

With regard to what policy alternatives might be available to encourage the modal shifts, CTR feels that federal and state governments have some flexibility and leverage in moving highway traffic to the waterways in Tennessee because these two agencies are responsible for much of the stone products moving in the state. Further the departments of transportation (or Cabinet in Kentucky) control the shipments moving from Tennessee quarries that produce materials needed in pavement mixes. CTR proposes consideration of the following actions:

- TDOT could examine relevant contracts to determine which of them incorporate stone shipments that could have moved by water transit. For a selection of each, the actual cost of truck transit should be compared against water transit to determine savings to be gained or subsidies that might be required for the modal shift. Any subsidies could be weighed against the economic and environmental benefits of the modal shift. This information could provide the basis for a program in which new contracts are examined for the potential for barge transportation use where appropriate.
- TDOT and the USACE could make modal preference integral to the contract-making process. This would involve both agencies investigating planned construction projects to determine if water transportation is an option in the movement of stone or other products and, if so, requiring its use.

- State government could advertise to alert Tennessee shippers as to the potential benefits of shipping by water. The interviews demonstrated that lack of knowledge is likely a common problem when companies make modal selections.
- Fourth, both TDOT and the USACE could investigate a multi-state corridor study to determine the benefits of using the navigable waterways as a transportation corridor. The long-distance stone movements passing in, out, or through multiple states, identified in the Global Insight data, can only be understood or addressed when state and federal governments have open communication lines. Long truck hauls from Tennessee into Mississippi are most likely destined for MDOT construction projects, and it would have to be MDOT that addresses the transportation issue. TDOT would not likely have sufficient information about the movement. The study has shown that a multi-state consortium could lower the cost of operating all of the DOTs, make better use of the waterway infrastructure, improve air quality, lessen congestion, and make the highways safer.

Last, the paper builds upon one of the aspects contained in "The Potential Contribution of Commercial Navigation to Freight Mobility in the Tennessee River Basin" project. One aspect of the study focuses on the "creation of a Water Transportation Advisory Group that would advise [Tennessee] Department of Transportation (TDOT) transportation planners in matters of needed upgrades to commercial barge transportation infrastructure." The paper includes a review of the Advisory Councils in other states and recommendations for representation in Tennessee.

Introduction

Motivation, and Scope of the Work

Prior to the onset of the recent economic downturn, surface freight transport providers faced dwindling capacity and mounting costs attributable to capacity related delays. While current economic conditions have temporarily relieved many, if not most, capacity shortfalls, underlying commodity flows remain largely unchanged, albeit with reduced tonnages, so that a rebounding economy will almost certainly make it necessary to revisit the longer-run questions surrounding the availability and affordability of freight transportation.

Motor and rail carriers operate over largely ubiquitous networks that make it possible for them to provide timely service from and to nearly every market. Waterborne commerce is, on the other hand, restricted by the more limited nature of the navigation network and by the ability to efficiently transload freight between modes. Still, for those regions of the country, like Tennessee, fortunate enough to have available barge transportation, it serves as a valuable freight resource. The question at issue is whether or not this resource can be further economically employed to help relieve the freight capacity constraints observed with the other surface modes, especially highway transport.

Transportation analysts may be well aware of the nature and relative volumes of traffic moving by truck, rail, and water. However, for commercial barge transportation to provide additional freight capacity relief, it will be necessary for some truck and rail movements in specific traffic lanes to divert to the waterway. To this end, this CTR study ultimately provides some answers to five pertinent questions:

- What commodities have potential for diversion to barge transportation?
- Would subsidies or incentives be necessary to accomplish diversions?
- Will Tennessee waterways be a conduit for container-on-barge traffic?
- What environmental and economic externalities might be associated with diversions?
- What policy alternatives might encourage diversions?

Additionally, the study addresses issues concerning the magnitude of expected air pollution benefits from the shifting of truck to barge transportation, how private barge carriers can be encouraged to secure certain needed floating equipment that might be necessary for the modal diversion to occur, the determination of projects in the State of Tennessee that might quality for the Congestion Mitigation and Air Quality (CMAQ) Improvement Program, and the creation of a Water Transportation Advisory Group that would advise Department of Transportation (TDOT) transportation planners in matters of needed upgrades to commercial barge transportation infrastructure.

Study Tasks

This paper concerns itself with seven primary tasks relating to traffic diversion to barge:

- examining and analyzing recent data for truck, rail and barge movements in Tennessee

- identifying potential candidates for a modal shift from rail and truck transportation to barge transit
- interviewing shippers and carriers for barge diversion potentials
- investigating federal and state government options to encourage diversion
- modeling selected truck diversions and estimating the resulting economic impacts
- drawing conclusions about potential barge diversion in Tennessee
- identifying advocates that would serve on a Tennessee Waterways Advisory Council

After preliminary investigation of current Tennessee freight patterns, the study ultimately focuses on six traffic types to assess their potential for modal diversion:

- general container-on-barge traffic
- freight transited via the Panama Canal
- high value commodities
- liquids
- coal
- dry bulk commodities

Having identified some candidate diversions from highway to rail or barge transportation components, the study models traffic conditions between Nashville and Clarksville for two selected potential barge diversions, transforming traffic and congestion impacts into additional fuel consumed, time spent in transit, air pollution, and crashes**.** Economic consequences are estimated by placing dollar values on each of the four effects, using data obtained from the ASSHTO Red Book (*User Benefit Analysis for Highways*) and the Environmental Protection Agency. This methodology was recently used by the Center for Transportation Research in a study of the potential closure of three navigation locks in the vicinity of Pittsburgh, Pennsylvania,[4] where it was determined that certain of the river traffic would move into Pittsburgh by truck transportation if one or more of the river navigation locks failed.

Candidates that might serve on the Tennessee Waterways Council are identified in Appendix A.

Tennessee Freight Traffic and Potential Diversions at the STCC2-Level

Overview

The initial task is to analyze the freight traffic in Tennessee and begin to attempt to identify some large movements likely to have potential for diversion from truck or rail to barge. To do this, the CTR has been given access to three confidential databases for this project: 2007 Global Insight TransSearch truck shipments file, the 2007 Freight Waybill Sample data for rail freightage, and the 2008 USACE Waterborne Commerce Statistical Center (WCSC) barge movement log. These data are not fully comparable in coverage and identification of commodities carried, and thus some flexibility is required to use them in concert. With the exception of the WCSC file, neither the freight

[4] Center for Transportation Research, *Social Costs of Barge Cargo Modal Diversions Due to Unscheduled Closures at Emsworth, Daschields, and Montgomery Locks, 2008*.

Waybill (which is a sample) nor the Global Insight truck data are best used to analyze traffic situations at a subregional level, but are more useful for assessing traffic at the national, state, or broad regional level. Global Insight identifies truck movements between counties for commodities at a four-digit STCC (Standard Transportation Commodity Code) level[5], but some significant truck movements in middle Tennessee, known to have taken place, seem to be missing from the data; for example, liquid asphalt is shown moving into Montgomery County, but pavement mixes are not recorded. Additionally, insufficient documentation was available for the truck data to fully clarify the meaning of some fields, such that, for example, the number of truck shipments represented by a record could not be reliably determined. The freight waybill data provide seven-digit STCC-coded commodity movements between counties, but the sampling is such that that the sub-state population estimates begin to become problematic, as well as specific data being undisclosable by the rules of use. The WCSC barge movement data, on the other hand, are Standard International Trade Classification (SITC)-coded commodity shipments between docks.

Table 1 shows, from the databases, for two-digit STCC (STCC2)-compatible tonnages for truck, rail and barge freight that moved within the borders of Tennessee—inbound, outbound, through, and local within Tennessee. Since the purpose of this project is to synthesize the data such that it can be used to help set state policy for modal decisions, the CTR used the most current data available at the time the research was undertaken. The 2008 WCSC data are one year more current than the other two files but remain reasonably comparable due to the general stability in traffic levels between 2007 and 2008.

Table 1: Truck, Rail and Barge Tonnages in Tennessee by Two-Digit STCC

		Thousands of Tons*		
STCC2	STCC2 Commodity Group	Truck	Rail	Barge
23	Apparel or other finished textile products or knit apparel	4,561	308	
28	Chemicals or allied products	55,684	21,111	2,328
32	Clay, concrete, glass, or stone products	30,980	9,397	1,476
11	Coal	1,368	107,101	23,844
42	Containers, carriers or devices, shipping, returned empty		1,432	
13	Crude petroleum, natural gas or gasoline	11		25
51	Drayage	15,388		
36	Electrical machinery, equipment, or supplies	11,920	258	
34	Fabricated metal products	25,176	159	
46/50	FAK Shipments (Rail) / Warehouse & Distribution Center (Truck)	75,601	13,960	
1	Farm products	34,787	29,436	5,851
20	Food and kindred products	55,707	19,301	846
8	Forest products	51		
9	Fresh fish	7	11	
25	Furniture or fixtures	4,850	87	
49	Hazardous Materials		16,960	

[5] See Appendix B: STCC2-STCC4 Commodity Groups for the four-digit composition of two-digit STCC classifications.

STCC2	STCC2 Commodity Group	Thousands of Tons* Truck	Rail	Barge
38	Instruments, photo goods, optical goods, watches, or clocks	1,673	21	
31	Leather or leather products	915	5	
24	Lumber or wood products, excluding furniture	29,572	8,075	1,119
35	Machinery, excluding electrical	13,145	304	131
43	Mail And Express Traffic		29	
10	Metallic ores	2,835	3,674	633
41	Miscellaneous freight shipments	16	408	
39	Miscellaneous products of manufacturing	3,475	60	
14	Nonmetallic ores, minerals, excluding fuels	87,785	4,139	10,031
19	Ordnance or accessories	43	92	
29	Petroleum or coal products	10,693	8,091	7,136
33	Primary metal products	31,522	8,839	3,741
27	Printed matter	5,227	63	
26	Pulp, paper, or allied products	21,217	12,633	
30	Rubber or miscellaneous plastics products	25,203	315	
22	Textile mill products	5,741	61	
21	Tobacco products, excluding insecticides	165		
37	Transportation equipment	17,827	8,741	
40	Waste or scrap materials not identified by producing industry	143	3,185	2,877
48	Waste, Other Regulated Materials Group E		120	
	Totals	573,289	278,376	60,038

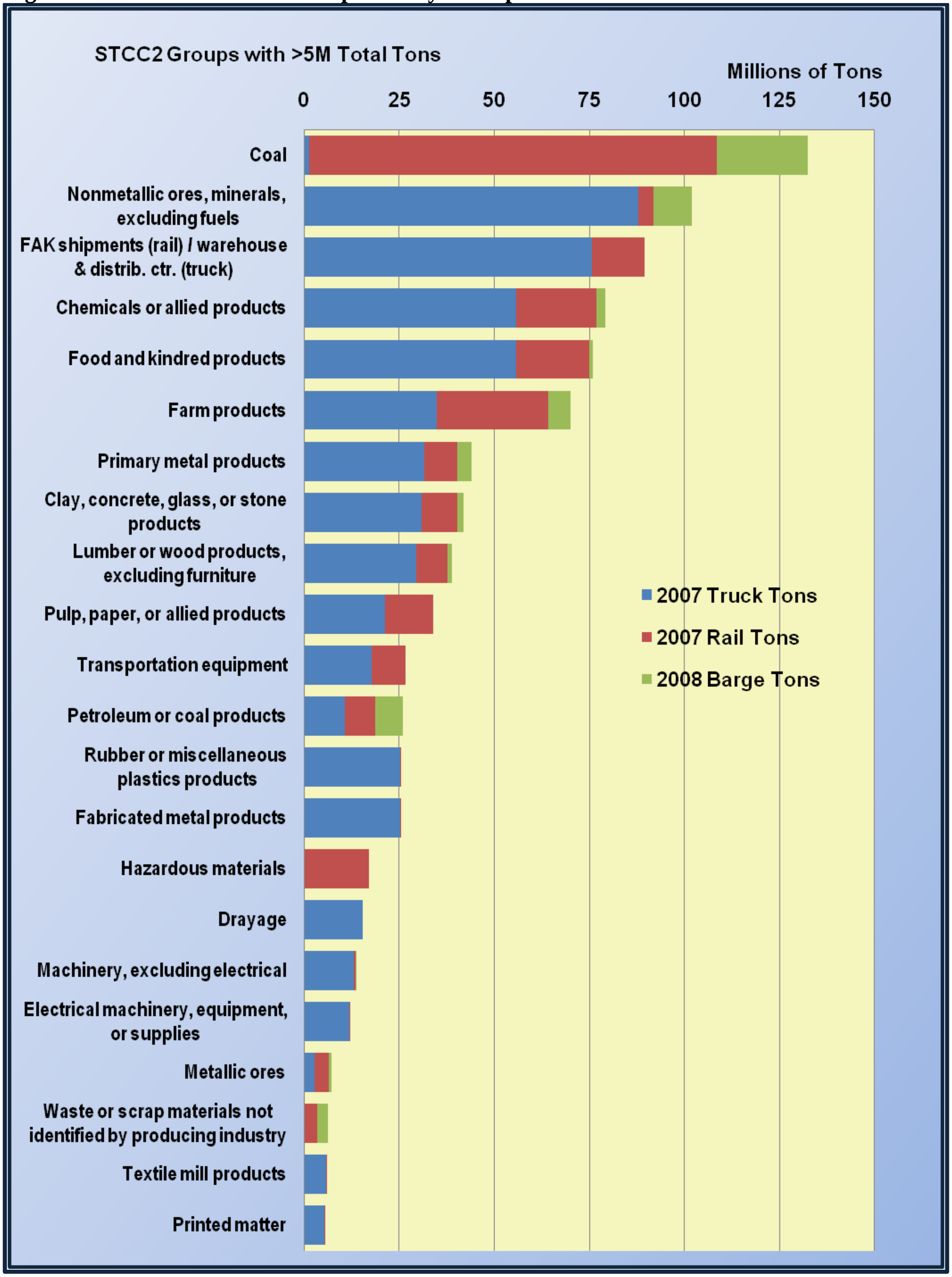
* Note that some goods were transported within Tennessee by more than one mode or, even, more than one carrier, and, therefore, constitute some multiple counting of tonnages for those goods.

Calculated from the table totals, trucking accounts for 62.9% of the tons, rail, 30.5%, and barge, 6.6%.

A bar chart, Figure 1 on the following page, graphically depicts this same data. It can readily be seen that truck accounts for the movement of most commodity tonnages, the significant exceptions being coal and hazardous materials, which are largely shipped by rail.

It is well known that truck, by and large, carries higher valued goods than rail, and barge carries large volumes of low-value dry and liquid bulk commodities. Truck's speed of delivery allows shippers and receivers to reduce costs by tying up less resources in higher-valued inventories, evident in some of the commodity groups in Table 1. **Truck transportation was used in Tennessee in 2007 to move 75.6 million tons of these generally higher valued commodities classified under 'warehouse and distribution.' Under current conditions, these goods probably have little potential for barge movement, unless, at minimum, significant investment is made in container-on-barge (COB) waterway facilities and equipment.** More detailed discussion of COB is provided in the Field Research section of this report.

Figure 1: Tennessee STCC2 Group Tons by Transport Mode



Other, more specific, categories of goods transported by truck include 55.7 million tons of chemicals, 55.7 million tons of food products, 34.8 million tons of farm products, and 31.5 million tons of primary metals. Trucks, however, also moved large quantities of lower-value, bulkier commodities: 133.7 million combined tons of clay, concrete, glass or stone products (STCC2 32); metallic ores (STCC 10); nonmetallic ores and minerals, excluding fuels (STCC2 14); petroleum or coal products (STCC 29); and coal (STCC2 11). These five STCC2 heavy commodity groups accounted for nearly one-quarter (23.3%) of total truck tons transported on Tennessee roadways.

By far, coal is the most important commodity for the rail industry operating in Tennessee, accounting for 38% of total rail traffic. Much of this traffic is destined for the Tennessee Valley Authority's (TVA) coal steam generating plants. While rail transportation is heavily used by TVA, barge transportation also serves several plants and provides a competitive alternative where barge and rail can compete for contract delivery. On the Cumberland River, barge transportation—although, possibly, not competitive with rail based on price alone—is preferred because unit train deliveries at the Gallatin Steam plant would cause excessive residential, commercial, and public safety problems, as the trains would block major access roads in the city while unloading. At the massive Cumberland City coal steam plant, barge transportation is the preferred mode of coal delivery because of a weight-restricted railroad bridge. In fact, the rail tracks serving the plant have been removed.

Excluding coal, the largest tonnages moved by rail in Tennessee (with percent of non-coal tons) are:

- farm products (17.2%)
- chemicals (12.3%)
- food and kindred products (11.3%)
- hazardous materials (9.9%)
- FAK (freight all kinds) (8.2%)
- pulp, paper, and allied products (7.4%)
- mineral products (clay, concrete, glass, or stone products) (5.5%)
- primary metal products (5.2%)
- transportation equipment (5.1%)

Together, these nine commodity groups constitute over 82% of the total non-coal tonnages moved by rail. Farm and food products combined account for 28.5%. Tennessee is known to be a net importer grain from outside the region.

Like the rail industry in Tennessee, coal accounts for a large portion (40%) of total barge traffic on the Tennessee and Cumberland Rivers. Table 1 and Figure 1 show that the varieties of commodities hauled by barge carriers is more limited than truck and rail transport. Barges carry large quantities of STCC2 14, nonmetallic and other mineral ores and STCC2 32, stone and mineral products. Barged farm products are important for Tennessee's exports and imports. In northern Alabama and southern Tennessee, barge and rail carriers compete on the basis of price for the import grain business. Corn grown west of the Mississippi River is more likely to be barged to Tennessee than railed, while corn grown east of the Mississippi River tends to be moved by rail. Also, grains moving to export markets tend to move by barge because the transfer from inland to deep water carriers can be made in midstream transfer, thus avoiding the high cost union labor required at the port facilities of Mobile and New Orleans.

Petroleum and steel are also important commodities to the water transportation industry. Light petroleum products are generally not competitive with pipeline transportation: the abandoned fuel tanks on Knoxville's Island Home Boulevard are a testament to this fact. The last barge shipment of gasoline to Knoxville was in the early 1970's when Colonial began providing pipeline service to upper east Tennessee. However, heavy petroleum products move most efficiently by barge transportation due to unloading economies. Steel and scrap metal are well suited for barge shipments. Close to the Tennessee-Alabama border, the largest shipper of manufactured steel products and the largest consumer of scrap metal is the Nucorp Steel Corporation in Decatur, Alabama. This facility has limited rail service and not enough "lay down" area to maintain an inventory of scrap metal adequate for a prolonged period. Thus, this facility relies on barge transportation to bring in scrap charge and to haul out finished steel. This facility receives truck and barge delivery of iron and steel scrap from Tennessee; a significant supplier of the scrap metals is Queen City Metals in Clarksville.

Truck Traffic

Statewide Truck Traffic

Table 1showed truck traffic in Tennessee totaled 573.3 million tons in 2007. This tonnage represents the summation of all truck movements in that year. Table 2, for truck movements greater than or equal to 50 miles, breaks down the truck tons moved by type of origin-destination location.[6] Most of the tonnage, 62%, originates and terminates outside Tennessee borders.

Table 2 : Truck Tonnages by Type of Origin-Destination

Movements Greater than 50 Miles		
Origin-Destination	Tons	Percent
TN Dest. Only	69,662,964	14%
TN Origin Only	80,932,855	16%
TN Origin & Dest.	42,507,671	8%
Through TN	308,488,649	62%
Total	501,592,140	

From Table 3 it can be seen that statewide Tennessee truck traffic (>50 miles) is dominated by 11 STCC2 groups, each of which is responsible for at least 20 million tons, together accounting for 82.5% of total truck traffic. The largest, those STCC2 groups with at least 40 million tons, are warehousing and distribution (14%), chemicals (11%), foods (11%), and nonmetallic ores and minerals (8%).

[6] From this point forward in this report, all truck data will include only those 50-mile or greater movements, as the principal goal of this report is to identify truck movements that have significant potential to shift to barge transportation, and very short truck movements, generally, are not likely to shift modes.

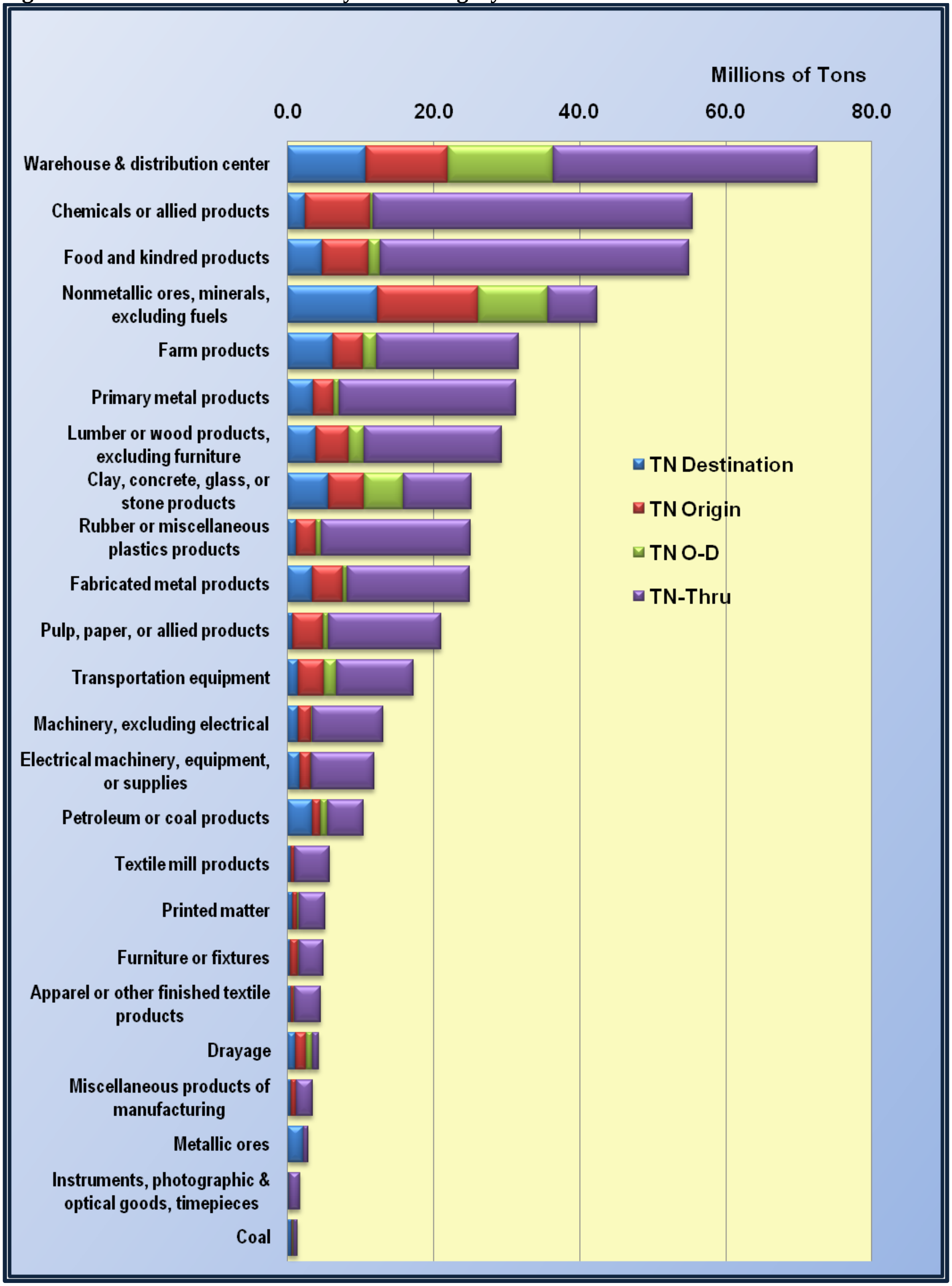
Of the STCC2 groups with the larger tonnages, only in nonmetallic ores and minerals does the preponderance of the traffic (84.2%) serve either or both shipping and receiving entities within Tennessee. Trucks carrying the other commodities are largely passing through, beginning and ending outside Tennessee. Through-shipments are particularly high in rubber and miscellaneous plastics (81.3%), chemicals (78.0%), primary metals (77.2%), food and kindred products (76.9%),

Table 3: Truck Tonnages by Origin-Destination Type for STCC2 Commodity Groups

	Millions of Tons for Movements >50 Miles				
Commodity	TN Destination Only	TN Origin Only	TN Origin & Destination	TN Thru	Total
Warehouse and distribution center	10.8	11.2	14.5	36.2	72.6
Chemicals or allied products	2.4	8.9	0.5	43.7	55.4
Food and kindred products	4.8	6.3	1.6	42.3	55.0
Nonmetallic ores, minerals, excluding fuels	12.3	13.8	9.5	6.7	42.4
Farm products	6.2	4.1	1.8	19.4	31.6
Primary metal products	3.5	2.8	0.8	24.1	31.2
Lumber or wood products, exc. furniture	3.9	4.5	2.1	18.8	29.3
Clay, concrete, glass, or stone products	5.6	4.9	5.3	9.4	25.2
Rubber or miscellaneous plastics products	1.2	2.7	0.8	20.4	25.1
Fabricated metal products	3.4	4.2	0.6	16.7	24.9
Pulp, paper, or allied products	0.7	4.2	0.7	15.4	21.0
Transportation equipment	1.5	3.5	1.7	10.6	17.3
Machinery, excluding electrical	1.5	1.7	0.2	9.6	13.1
Electrical machinery, equip., or supplies	1.7	1.6	0.1	8.6	11.9
Petroleum or coal products	3.4	1.1	0.9	5.0	10.4
Textile mill products	0.4	0.5	0.1	4.6	5.7
Printed matter	0.7	0.7	0.3	3.5	5.1
Furniture or fixtures	0.4	1.0	0.2	3.2	4.8
Apparel or other finished textile products	0.5	0.4	0.0	3.6	4.6
Drayage	1.1	1.4	0.8	0.8	4.2
Miscellaneous products of manufacturing	0.5	0.7	0.0	2.2	3.5
Metallic ores	2.1	0.0	-	0.7	2.8
Instruments, photo. & optcl. gds., timepcs.	0.2	0.1	0.0	1.4	1.7
Coal	0.6	0.1	0.2	0.5	1.3

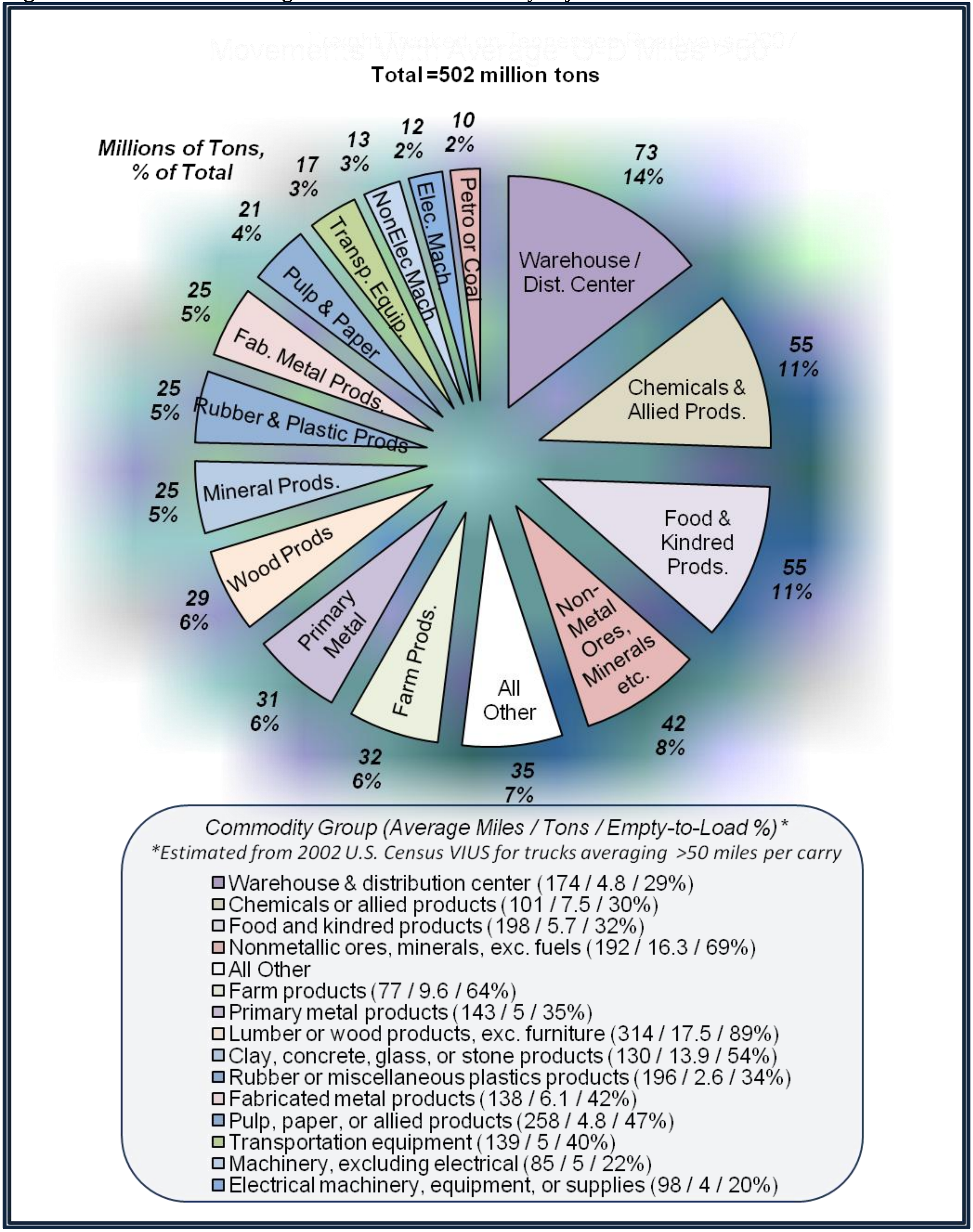
The orientation of Tennessee truck traffic toward being thru-based, shown graphically in Figure 2, makes evident that **only in the resource based STCC2 groups of nonmetallic ores and mineral products (and, secondarily in petroleum and coal products) do shipments from or to Tennessee locations dominate the traffic patterns.**

Figure 2: Tennessee Truck Tons by O-D Category in 2007



The distribution of tonnage moving on Tennessee roadways in each STCC2 commodity group is shown in Figure 3. About one-half of the tonnage can be seen to be concentrated in five commodity groups: warehouse and distribution centers (14%), chemicals (11%), food and kindred products (11%), nonmetallic ores and minerals (8%), and farm products (6%).

Figure 3: Distribution of Freight on Tennessee Roadways by STCC2



The pie chart legend provides additional information potentially relevant to barge diversion: estimates of the average miles per shipment, average tons per shipment, and average empty-to-load ratio.[7] Barge tends to be more economical where long distances and heavy goods are involved. Longer distance moves are more likely to involve more miles of use of Tennessee roads. The following are the charted commodities with the longest average movements:

- lumber or wood products, excluding furniture – 314 miles
- pulp, paper, or allied products – 258 miles
- food and kindred products – 198 miles
- rubber or miscellaneous plastic products – 196 miles
- nonmetallic ores and minerals, excluding fuels – 192 miles

Nonmetallic ores and minerals, excluding fuels, is the fourth largest tonnage group and, at 16.3 tons, this group ranks as one of the heaviest loads per truck. **Its bulk and distance characteristics, along with the large quantities moved, suggests that non-metallic ores and minerals is a good candidate to examine for potential barge diversions. Lumber and wood products (17.5 tons per truck) is also a heavy-movement class of commodities, as is mineral and stone products (13.9 tons per truck), and petroleum and coal products (11.9 tons per truck). The heavier movements, of course, place more load on the roadway, resulting in more maintenance, so getting some of those movements off the road could be particularly beneficial.**

Truck Traffic In Tennessee Major Metropolitan Waterway Counties

Major metropolitan areas with waterway access would seem to be good places to look for large shipments that might be diverted to barge, which would be especially true if the nature of the commodities and available water facilities were to make some aggregations of shipments possible. In addition, it is expected that the greatest benefits from mitigating congestion and other negative externalities are likely to occur in these areas of more concentrated populations.

The regional pattern of commodity truck traffic varies with the industrial composition of each local area as well as the origin-destination basis of the freight carried. In this section consideration is given to potential commodity groups in the local areas that might contain shipments or aggregates of shipments that are arguably barge-able, even if such movements are likely dependent on conditions that may not currently exist and require some vision to entertain the possibilities. To explore this possibility, we now examine the major categories of commodity traffic for the five major counties in Tennessee that lie on navigable waterways.

Davidson County

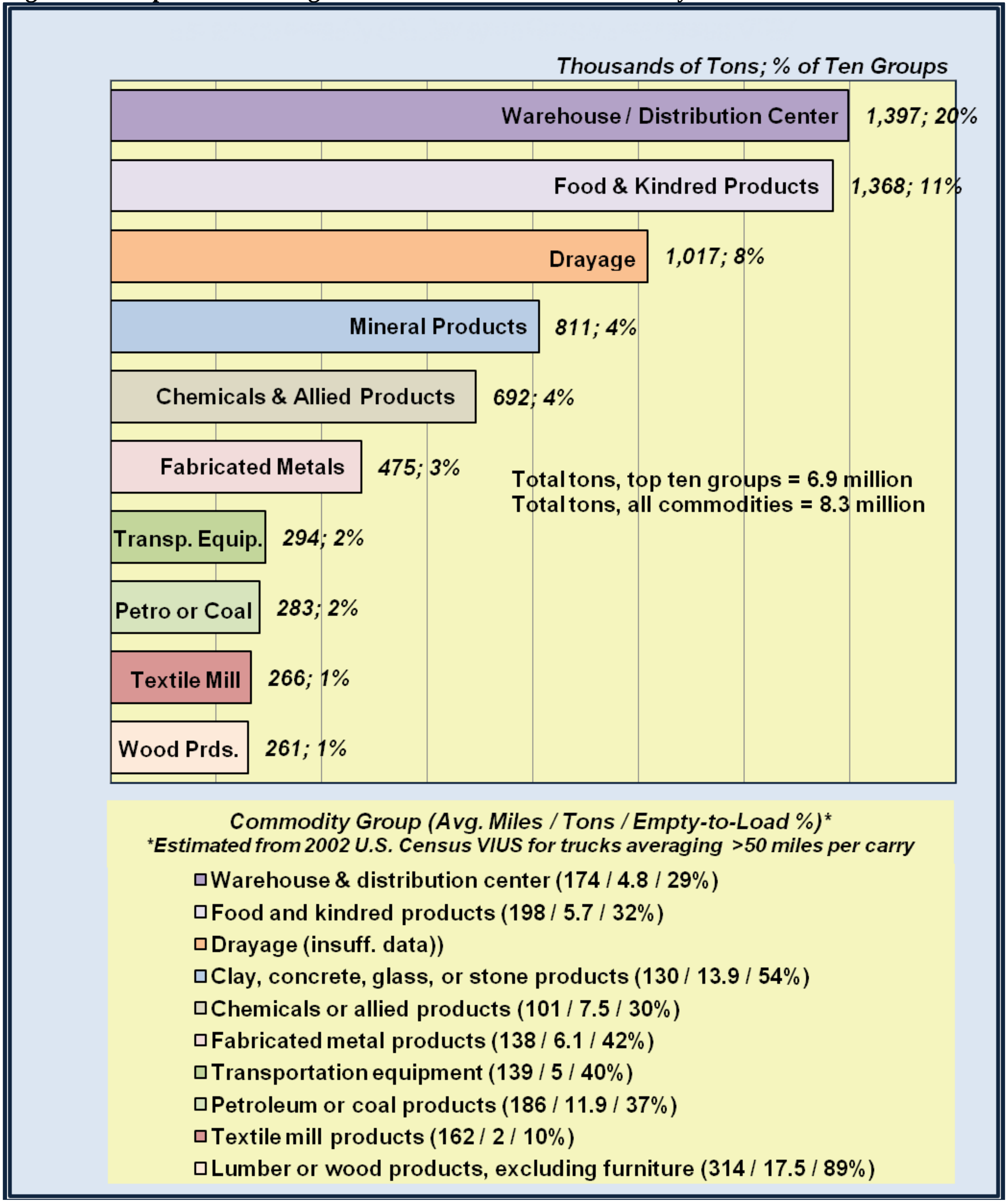
Figure 4 shows Davidson County's outbound commodity distribution, which is dominated by a select few commodity groups, including warehouse and distribution center commodities, food and kindred products, drayage, mineral products (clay, concrete, glass, or stone products), and chemicals. The drayage classification is commonly applied to containerized cargo and here, likely to trailers also.

[7] In this and pie charts to follow, legends include average miles, tons, and empty-return ratios that CTR has calculated from the 2002 Census VIUS. These values are uncertain. There appears to be a fairly wide range, particularly for tons per shipment, reported in the literature. For two sets of alternative reported values, refer to Appendix C: Alternative Calculations of Tons Per Truck.

The CSX railroad has an intermodal facility in the county, although CSX is not currently shipping trailers out of that facility.

Mineral products and chemicals are the most likely to contain specific movements that might be barged. Warehouse and distribution center commodities and drayage are unlikely to be barged unless some sort of container-on-barge (COB) capability could be developed.

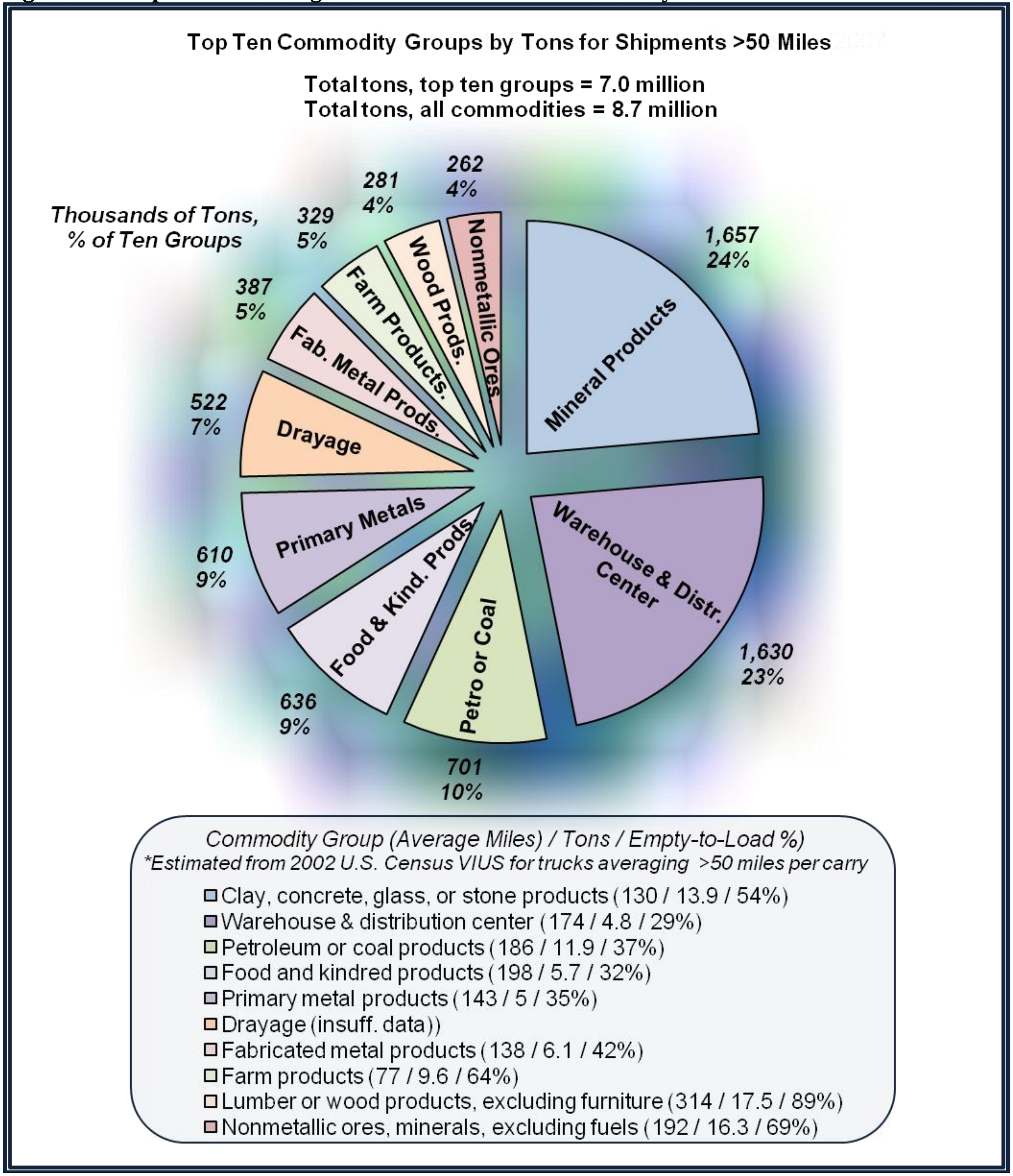
Figure 4: Composition of Freight Trucked Out of Davidson County



Inbound traffic, shown in Figure 5, into Davidson County is dominated by minerals products (clay, concrete, stone, or glass) and warehouse and distribution goods. Again, mineral products shipments, being generally a good commodity group for barging, should be, therefore, a good place to look for specific inbound shipments that might be diverted. Petroleum or coal products are also significant and appear to typically be heavier loads; the relatively large quantities trucked into the Nashville/Davidson County metropolitan area are due to its not being served by a major pipeline. Food and kindred products and primary metals, though, perhaps, lighter loads on average, might also have some potential.

Though COB may not be feasible, until that is settled, perhaps the fact that warehouse and distribution is a large segment of truck movements should not be overlooked here or in the other major waterway counties, all of which have large segments of trucking of these goods, either in, out, or both; this is especially true since potential for reduction of congestion benefits are almost certainly greatest in these areas.

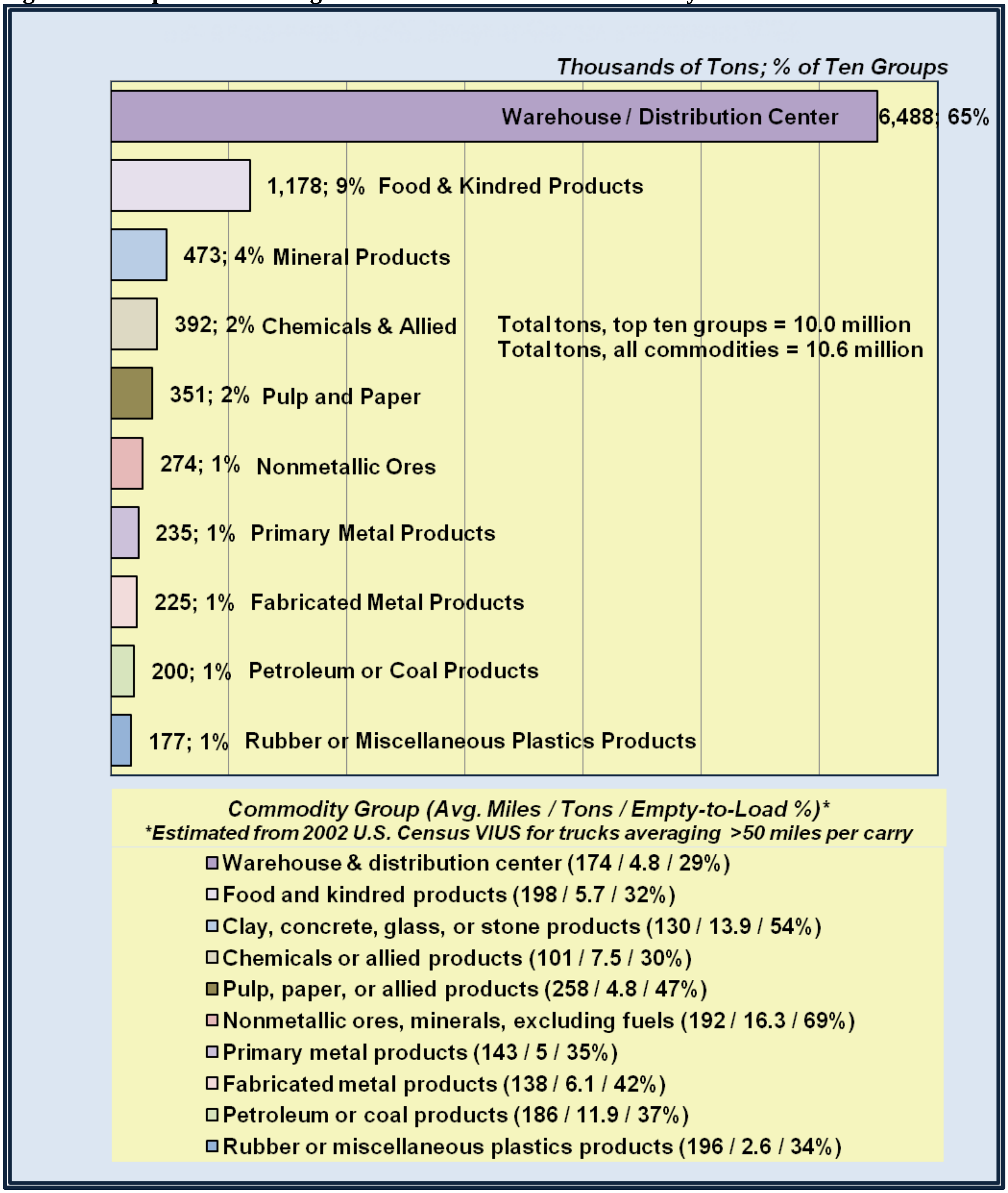
Figure 5: Composition of Freight Trucked Into Davidson County



Hamilton County

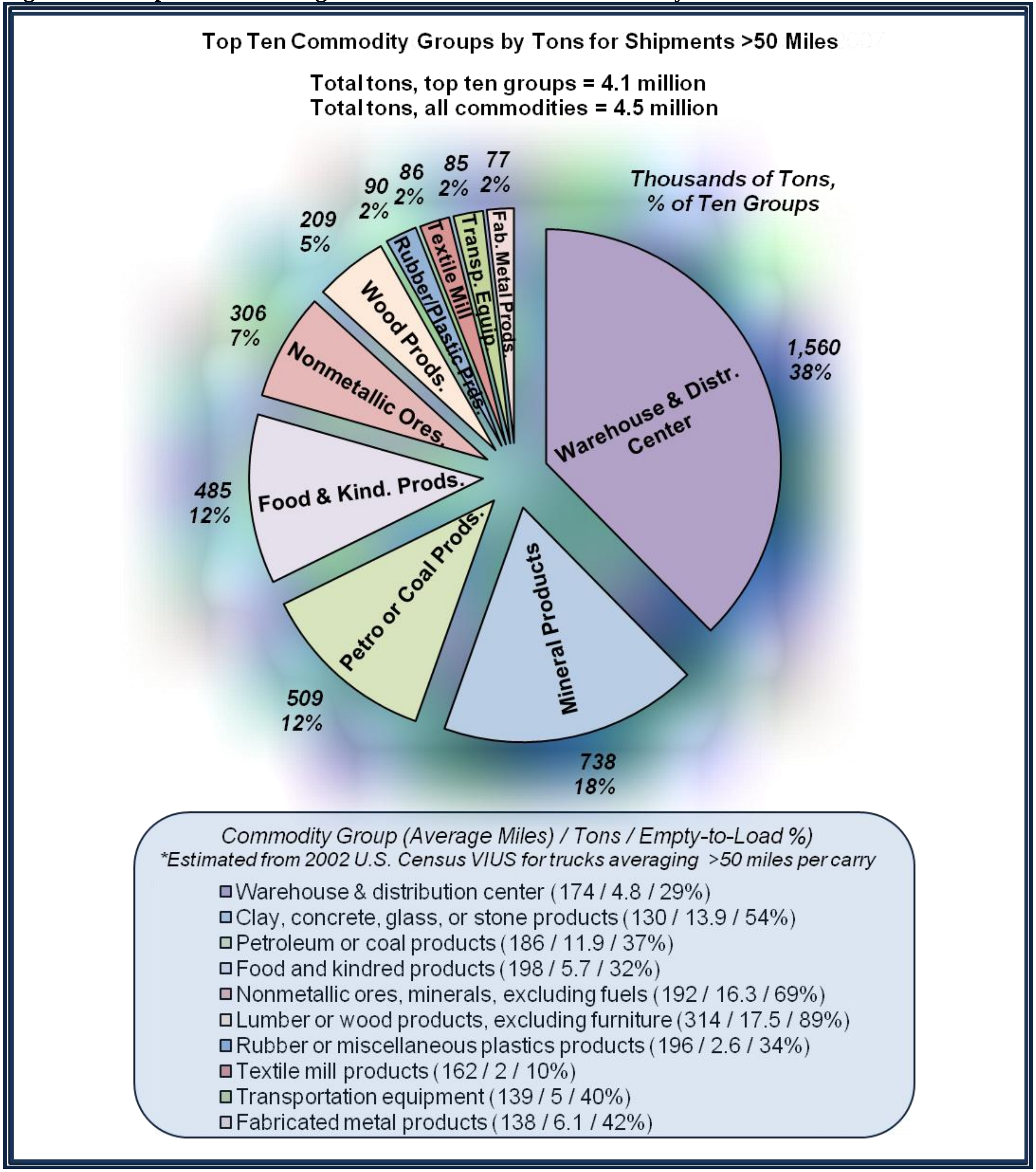
The distribution of freight trucked out of Hamilton County is shown in Figure 6. This distribution is unique among the major metropolitan areas in Tennessee as Chattanooga is a major national center for warehousing and distribution center for shipment to other areas. An amazing 65% of the tonnage trucked out of Hamilton County is classed as warehousing and distribution. The second largest group is food and kindred commodities, probably accounted for by a large baking industry in Hamilton County. Everything else is smaller, and, therefore, less likely to contain shipments of the tonnages needed to make barge feasible. Nevertheless, the mineral products group is significant at nearly 500 thousand tons.

Figure 6: Composition of Freight Trucked Out of Hamilton County



The distribution of freight trucked into Hamilton County is also heavily weighted toward warehouse and distribution center goods. As mentioned previously, this group is not currently likely to barge to any significant degree, and only if some type of COB capability were to be developed, which might be unlikely with the current emphasis on just-in-time deliveries, would these goods be viable barge diversion candidates. However, inbound minerals products and mineral ores are also substantial commodities coming in by truck to the county, and these may contain candidates for barge shipping. The same is true for petroleum or coal products. The composition of freight traffic into Hamilton County is shown in Figure 7.

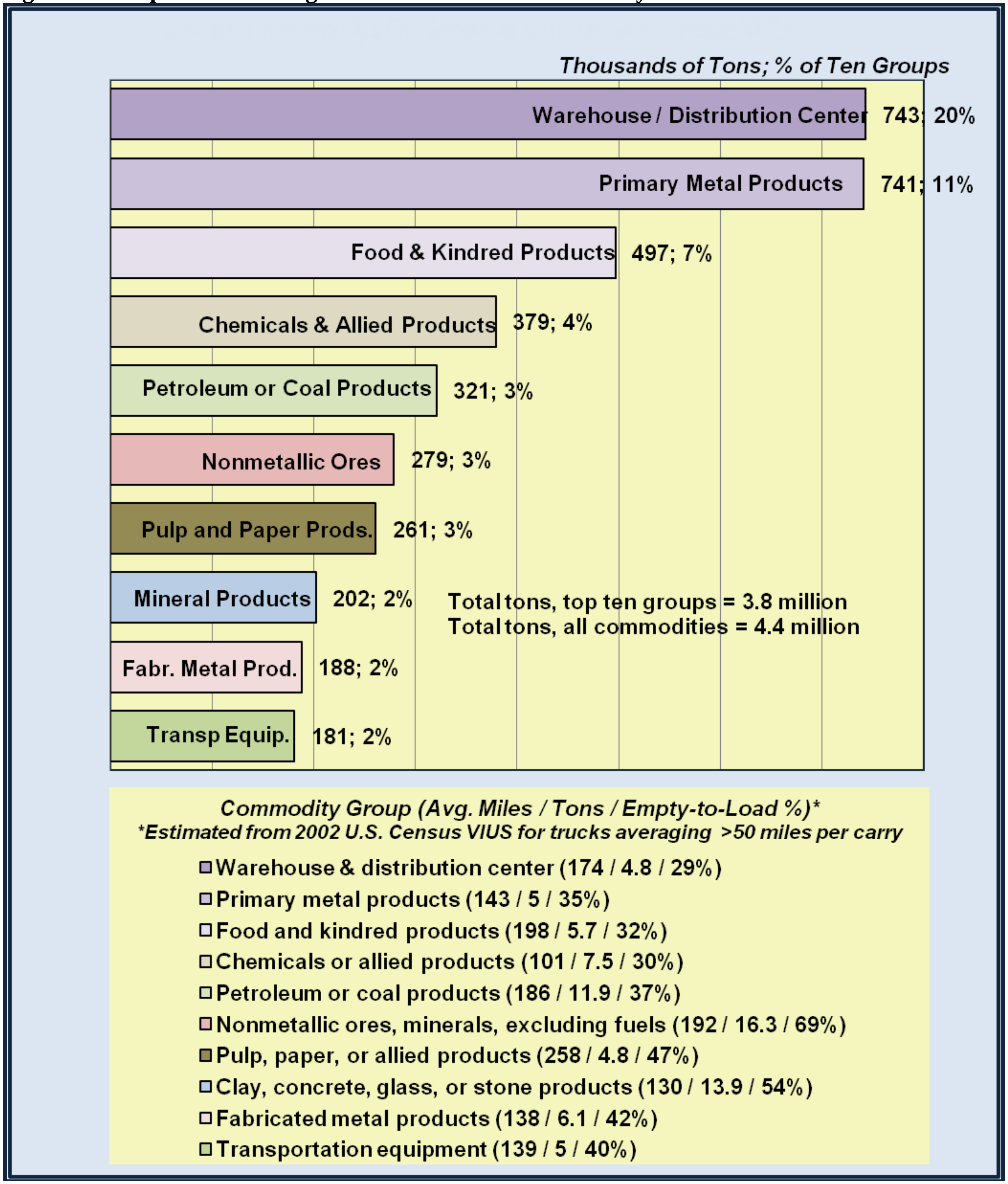
Figure 7: Composition of Freight Trucked Into Hamilton County



Knox County

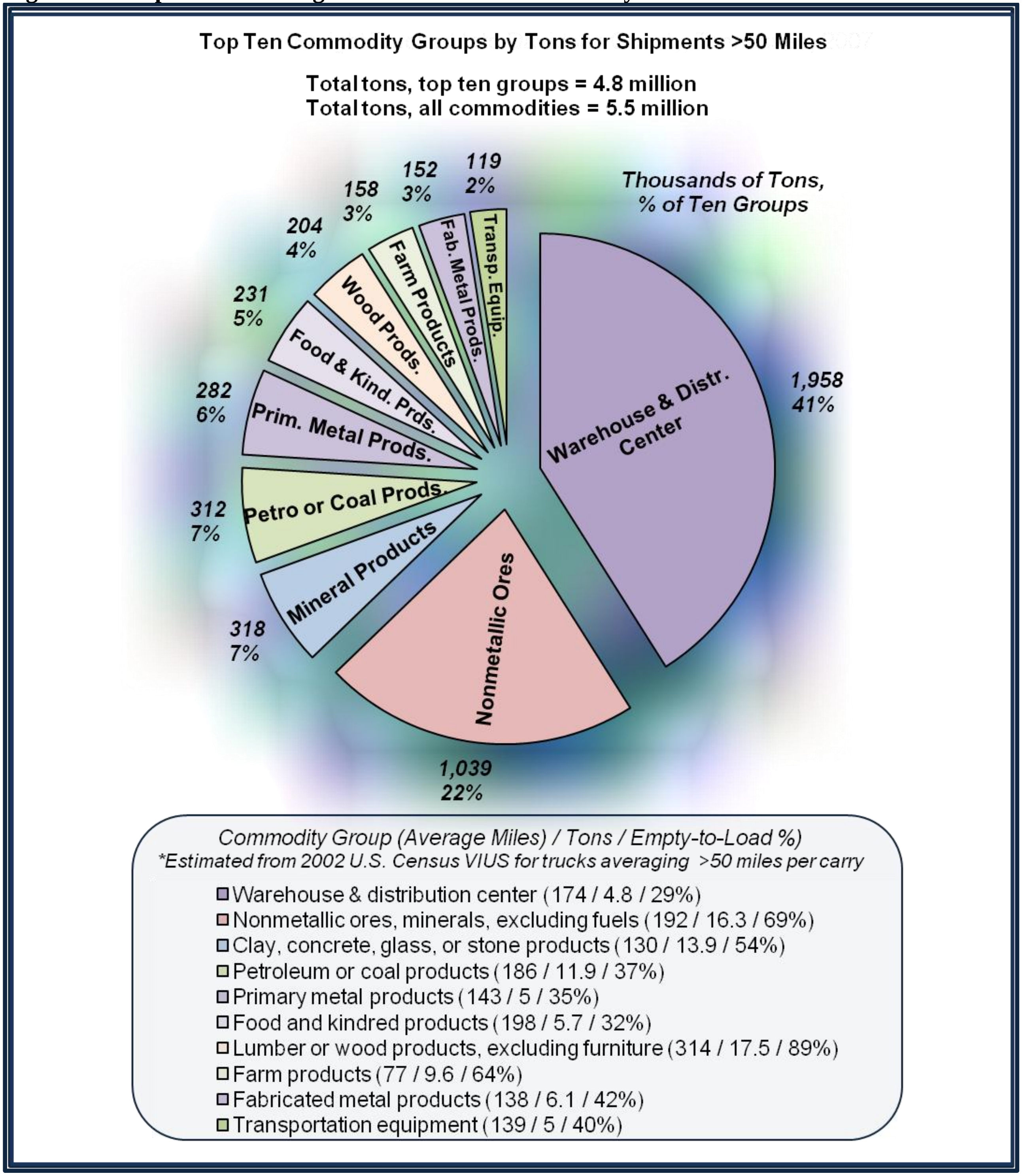
The commodity distribution of freight trucked out of Knox County is somewhat more uniformly distributed than was found in either Davidson or Hamilton Counties. Figure 8 shows ten commodity groups that have at least five percent of total outbound truck traffic, with four groups dominating: warehousing and distribution (20%); primary metals (20%); food and kindred products (13%); and chemicals (10%). The latter three may be worth closer looks at specific movements for potential barge diversion.

Figure 8: Composition of Freight Trucked Out of Knox County



Commodity traffic trucked into Knox County is shown in Figure 9. Warehousing and distribution center goods and mineral ores dominate the shipment pattern, accounting for close to two-thirds of the tonnages. Mineral ores and mineral products together account for almost 30% or the total, and, again, are good candidates in which to explore possibilities of diversion to barge, along with petroleum or coal products, primary metals, food and kindred products, and wood products.

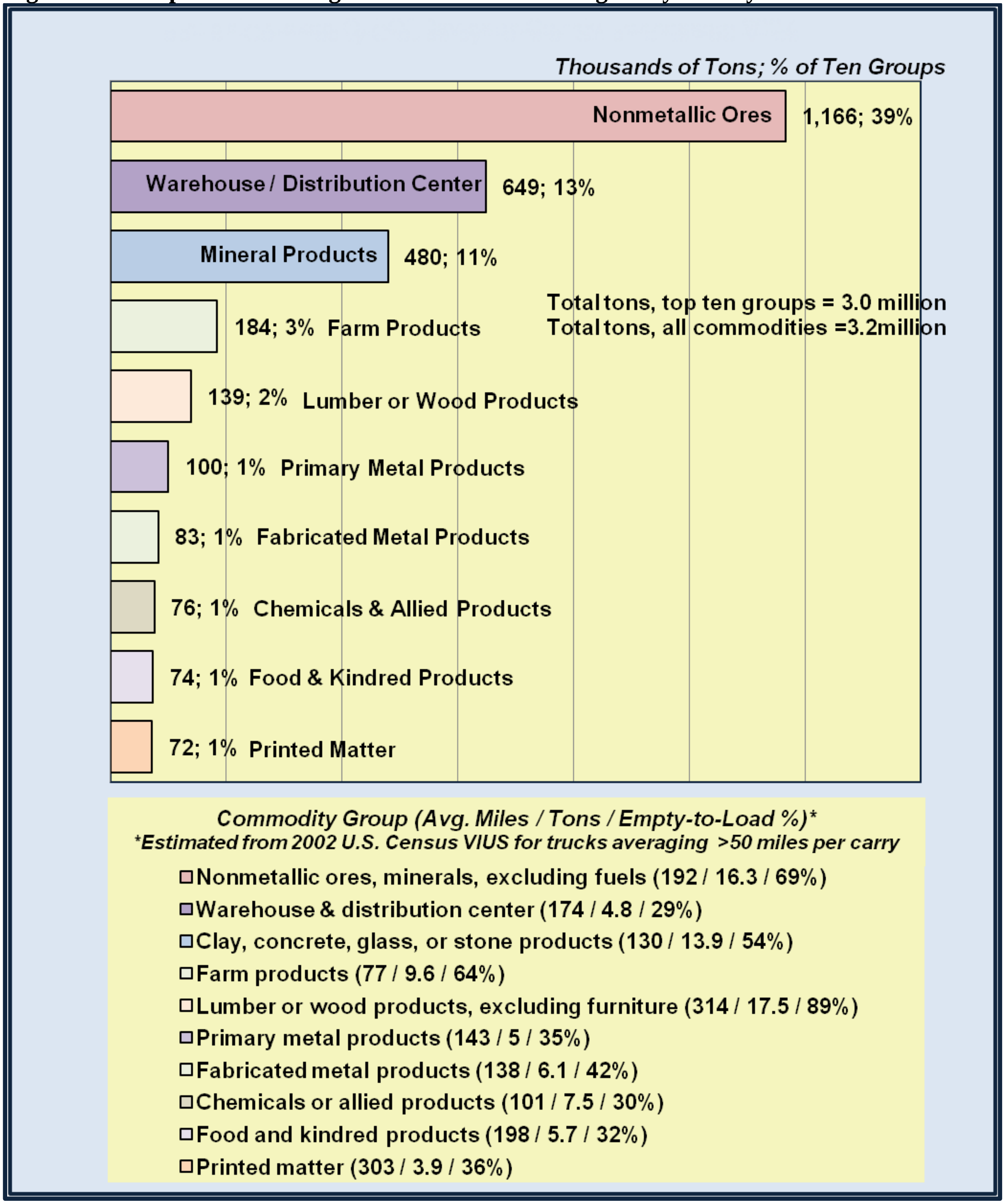
Figure 9: Composition of Freight Trucked Into Knox County



Montgomery County

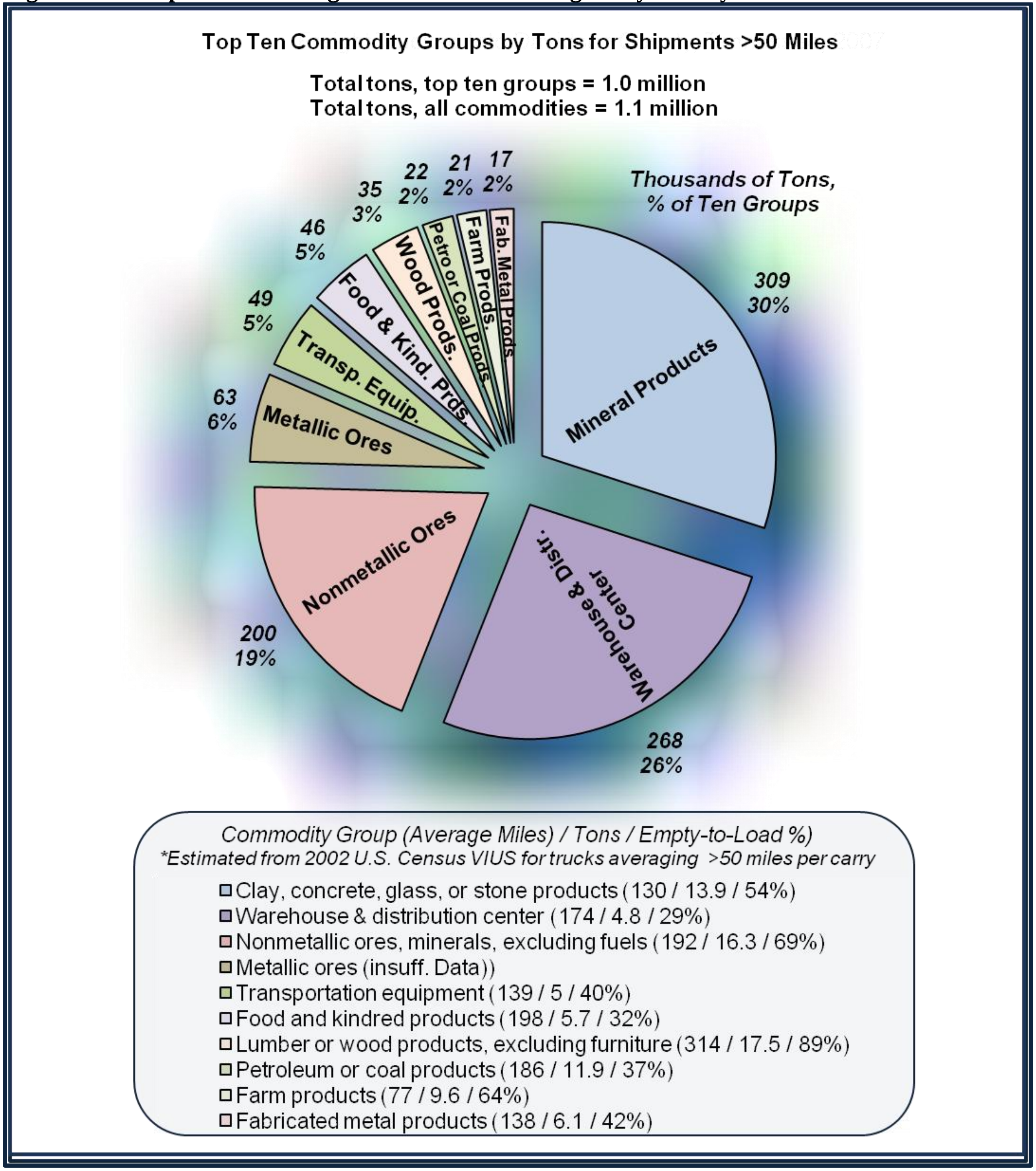
A major group of commodities outbound from Montgomery County are mineral ores and mineral products, together accounting for 55% of total outbound truck tons. Minerals trucked out of the county (39% or total outbound traffic) are, to a large degree, "non-polished" stone, a major ingredient in asphalt topcoat material which is used in repaving highways. This is investigated more fully in the field research section later in this report.

Figure 10: Composition of Freight Trucked Out of Montgomery County



The bulk of shipments into Montgomery are similar to the outbound commodity groups: mineral ores and products and warehouse and distribution centers. **The mineral shipments are promising and , as will be further discussed later in this report, are dominated to a degree by truck movements from commercial barge terminals in Davidson County.** The Clarksville/Montgomery County area does not have a general purpose commodities terminal with adequate storage and the infrastructure to handle bulk liquid and dry commodities. Thus, barged commodities are unloaded in Nashville and trucked back to Clarksville. These commodities include liquid asphalt, gasoline, cement, and sand. Ohio River sand is also trucked to Clarksville to the west of the city. The composition of freight trucked into Montgomery County is shown in Figure 11.

Figure 11: Composition of Freight Trucked Into Montgomery County



Shelby County

Figure 12 shows the traffic trucked out of Shelby County. This traffic consists mostly (83% of the total tonnages) of warehouse and distribution goods (45%); chemicals (19%), food and kindred products (12%), and pulp and paper products (7%). There may be some diversion opportunities in the latter three groups of commodities.

Figure 12: Composition of Freight Trucked Out of Shelby County

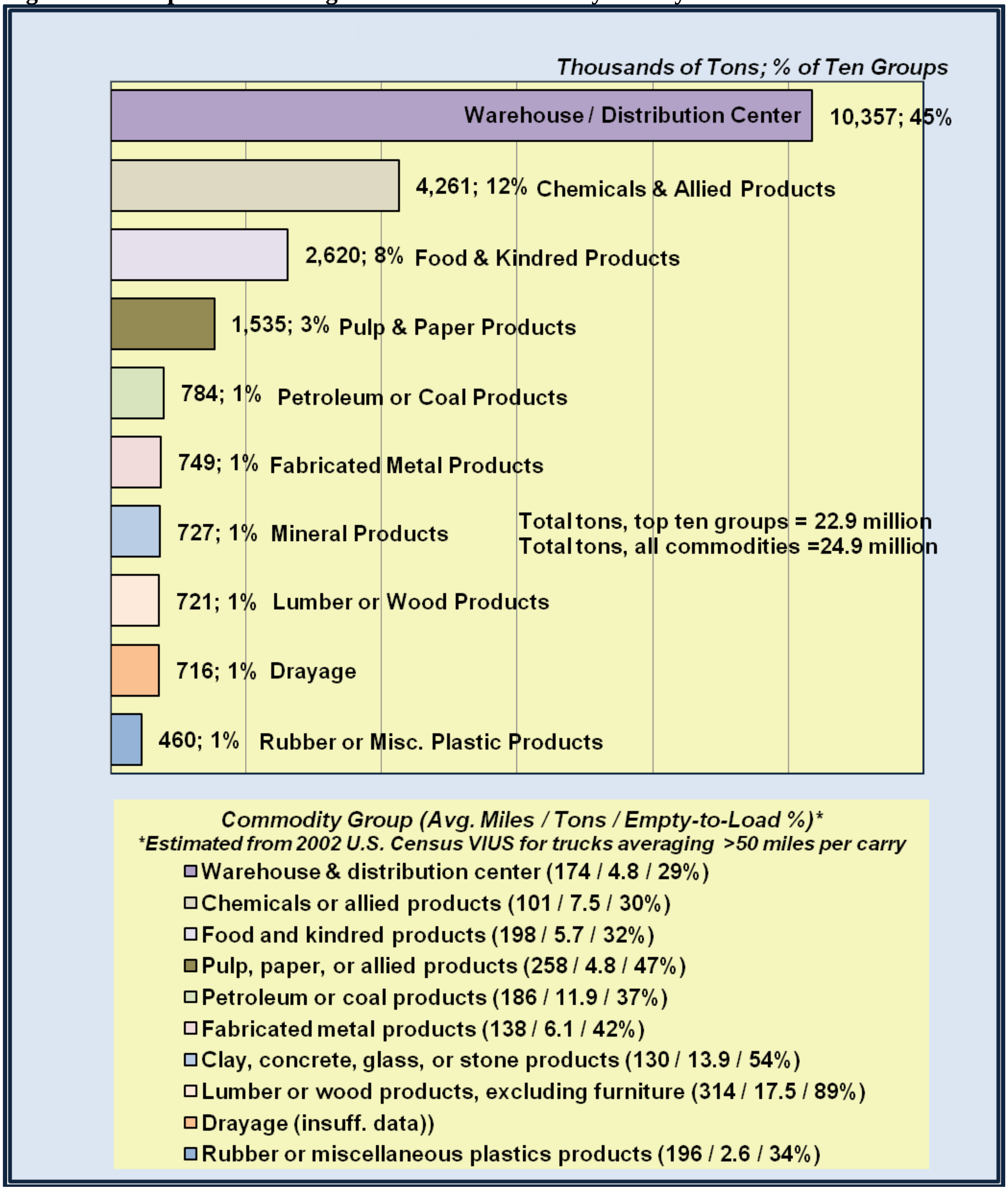
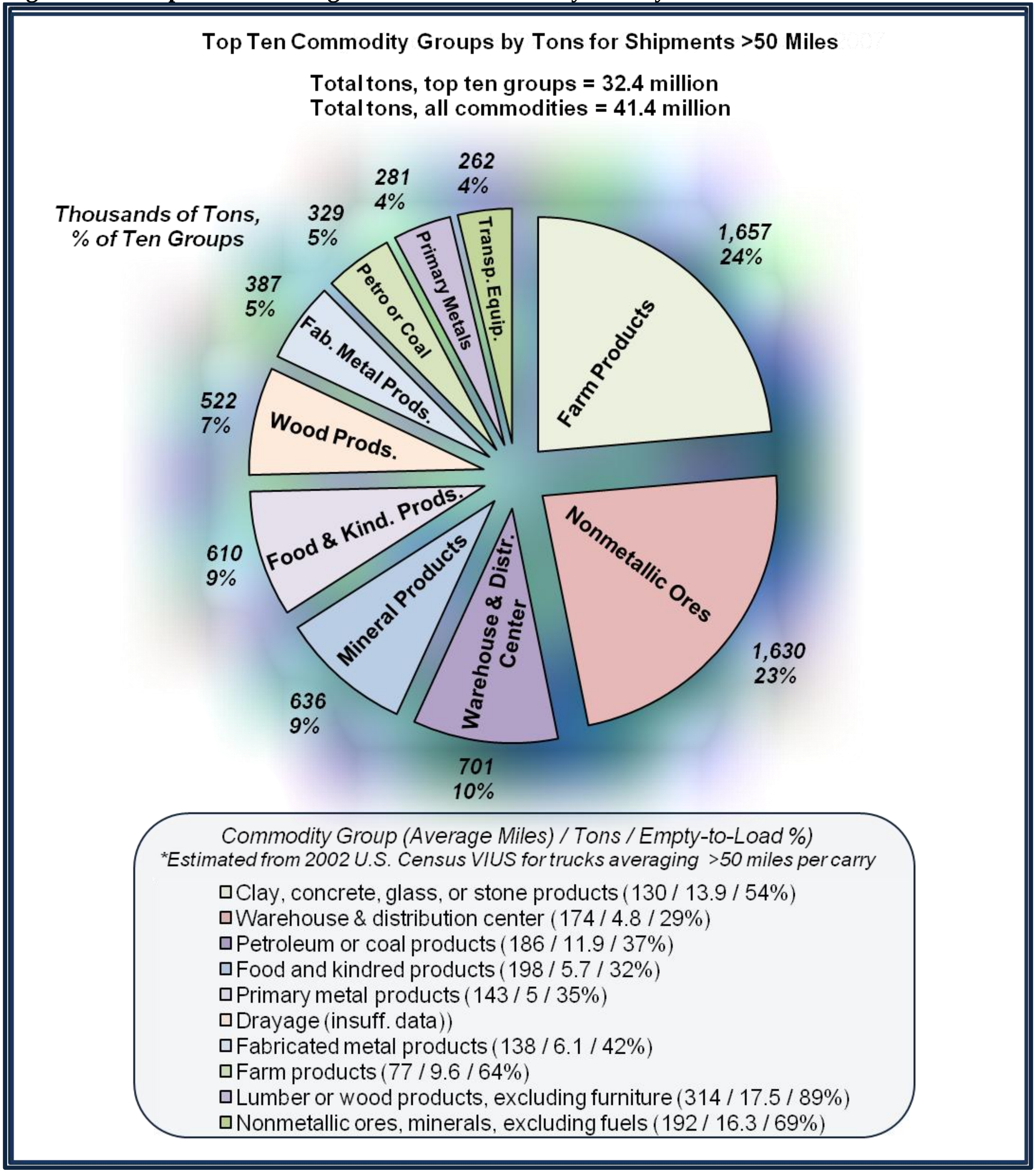


Figure 13 shows the volume of tonnage trucked into Shelby County by commodity. The traffic is distributed fairly widely by commodity groups, but the more dominant shipments are farm products (19%), mineral ores (16% or 5.4 million tons), warehousing and distribution goods (14%), and mineral products (11% or 3.5 million tons). Farm products tend to be shorter hauls with the average distance being only 77 miles, so the likelihood of barging may be reduced. **The mineral ores and products, though, are large and, if barge diversion is possible in any of the five metro areas, Shelby would seem to be a most likely place to find candidate shipments. The problem with Shelby, however, is that to use barge for truck movements that travel Tennessee roadways, the barge routes may often be unduly long, moving, at least initially, on the Mississippi River.**

Figure 13: Composition of Freight Trucked Into Shelby County



Rail Traffic

Statewide Rail Traffic

Table 4 shows that 291.4 million tons of rail traffic in 2007 had a Tennessee origin, a Tennessee destination or moved through the state.[8] **Coal accounts for 41% of the tons moved, and 61.2% was through traffic.** Other major groups of commodities railed inside Tennessee include farm products (29.4 million tons); chemicals and allied products (21.1 million tons); food and kindred products (19.3 million tons); hazardous materials (17.0 million tons); FAK[9] (14.0 million tons); and pulp, paper, and allied products (12.6 million tons). Two digit rail STCC traffic is shown graphically in Figures 13 and 14. The dominance of coal is shown in Figure 13. **Without coal (Figure 14), farm products, chemicals, food products, and hazardous materials, FAK, and pulp and paper products dominate, followed by mineral products and primary metal products**. The percentage distribution of each major commodity classification (excluding coal) is shown in Figure 15.

Table 4: Tennessee Rail Traffic in 2007 by Origin and Destination Category

	Million Tons				
Commodity	TN Destination	TN Origin	TN O-D	TN-Thru	Total
Coal	27.6	17.4	1.5	73.6	120.2
Farm products	5.0	1.4	0.2	22.9	29.4
Chemicals or allied products	3.1	1.8	0.3	16.0	21.1
Food and kindred products	4.9	2.7	0.3	11.5	19.3
Hazardous Materials	3.4	1.7	0.2	11.6	17.0
FAK Shipments	4.3	4.3	0.1	5.3	14.0
Pulp, paper, or allied products	1.7	1.6	0.1	9.2	12.6
Clay, concrete, glass, or stone products	1.0	2.4	0.3	5.7	9.4
Primary metal products	1.3	0.8	0.0	6.7	8.8
Transportation equipment	1.2	1.6	0.3	5.6	8.7
Petroleum or coal products	0.3	0.1	0.0	7.7	8.1
Lumber or wood products, excluding furniture	2.3	1.3	0.1	4.4	8.1
Nonmetallic ores, minerals, excluding fuels	1.3	0.2	0.1	2.6	4.1
Metallic ores	0.4			3.3	3.7
Waste or scrap materials not id'd by producing ind.	0.3	1.0	0.1	1.8	3.2
Containers, carriers or devices, shpng, returned empty	0.3	0.4	0.0	0.8	1.4
Miscellaneous freight shipments	0.1	0.0	0.0	0.3	0.4
Rubber or miscellaneous plastics products	0.1	0.1		0.2	0.3
Apparel or other finished textile products or knit apparel	0.0	0.1		0.2	0.3
Machinery, excluding electrical	0.0	0.1	0.0	0.2	0.3
Electrical machinery, equipment, or supplies	0.0	0.0		0.2	0.3

[8] Resulting from Rail Accounting Rule 11, the rail movement of goods and commodities are sometimes double counted--this happens where transloading occurs from one rail line to another. An example is the transloading of western coal in Shelby County Tennessee.

[9] FAK represents a miscellaneous assortment of commodities shipped at one freight rate. The acronym means "freight of all kinds".

Commodity	TN Destination	TN Origin	TN O-D	TN-Thru	Total
	Million Tons				
Coal	27.6	17.4	1.5	73.6	120.2
Fabricated metal products	0.0	0.0		0.1	0.2
Waste Other Regulated Materials Group E	0.0	0.0	0.0	0.1	0.1
Ordnance or accessories				0.1	0.1
Furniture or fixtures	0.0	0.0		0.0	0.1
Printed matter	0.0	0.0		0.0	0.1
Textile mill products	0.0	0.0		0.0	0.1
Miscellaneous products of manufacturing	0.0	0.0		0.0	0.1
Mail And Express Traffic	0.0	0.0		0.0	0.0
Instruments, photo goods, optcl gds, watches, or clocks	0.0	0.0		0.0	0.0
Fresh fish	0.0	0.0		0.0	0.0
Leather or leather products	0.0	0.0		0.0	0.0
Forest products				0.0	0.0
Total	58.7	38.9	3.7	190.2	291.4

Figure 14: Two Digit STCC Tennessee Rail Traffic Including Coal

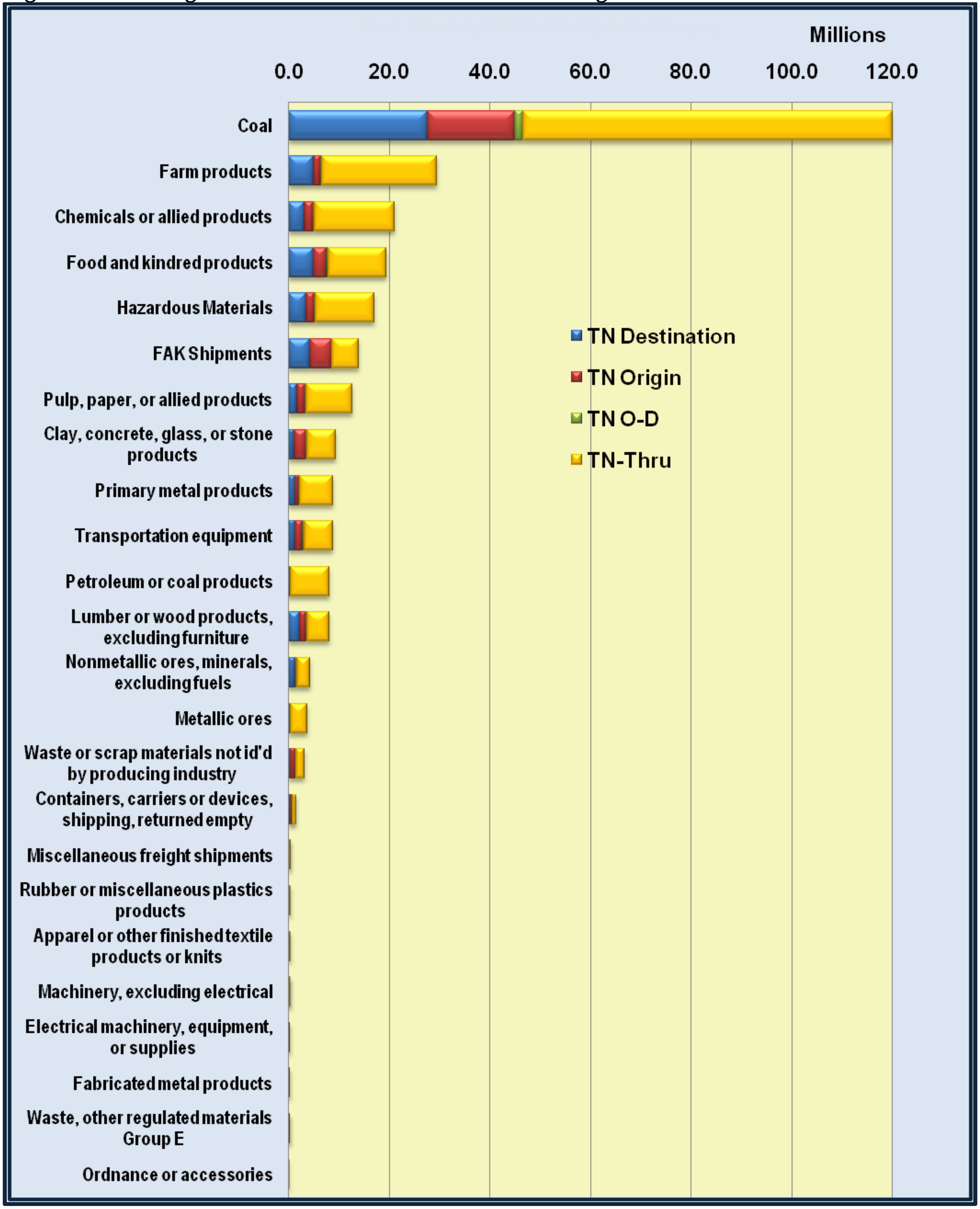


Figure 15: Two Digit STCC Tennessee Rail Traffic Excluding Coal

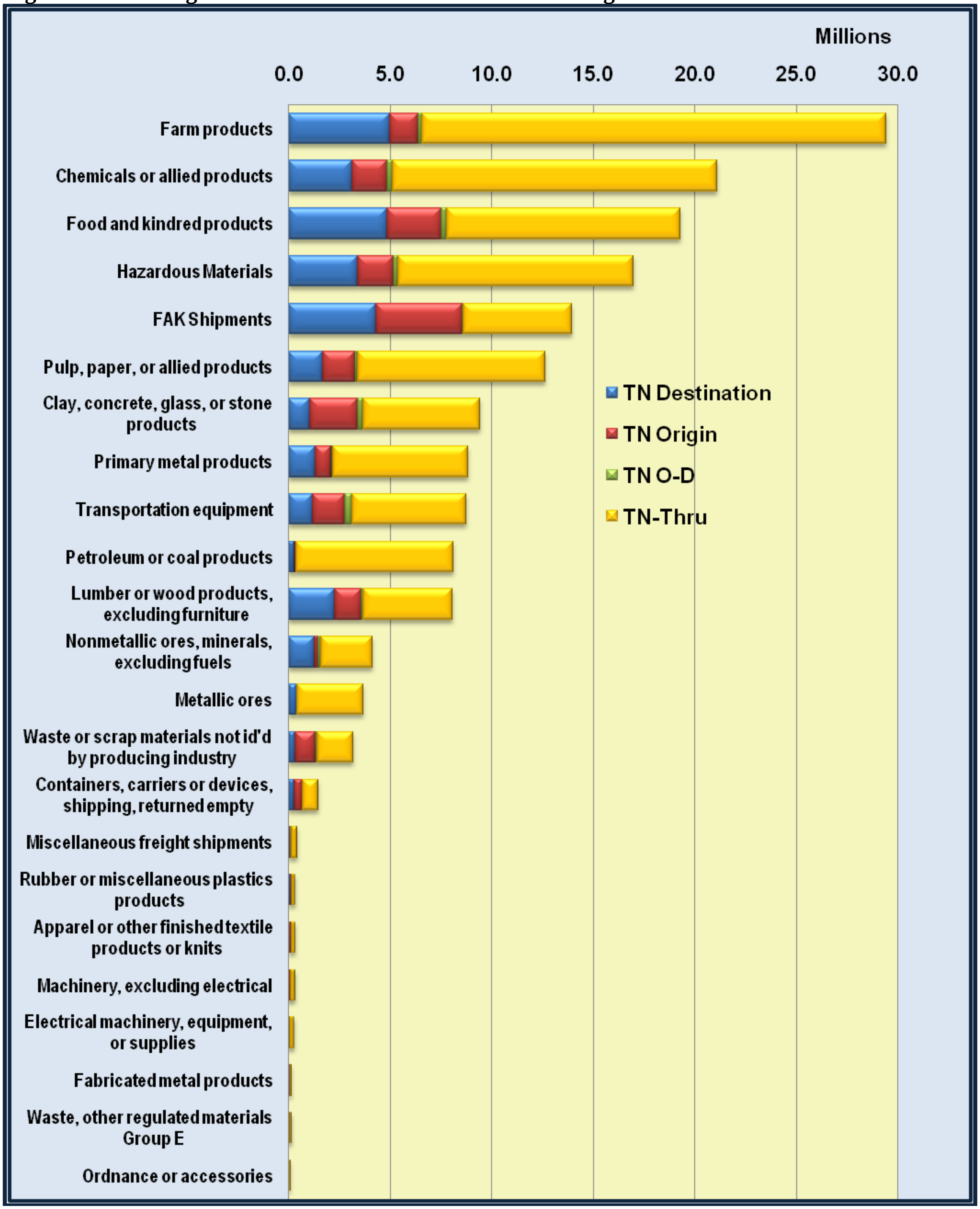
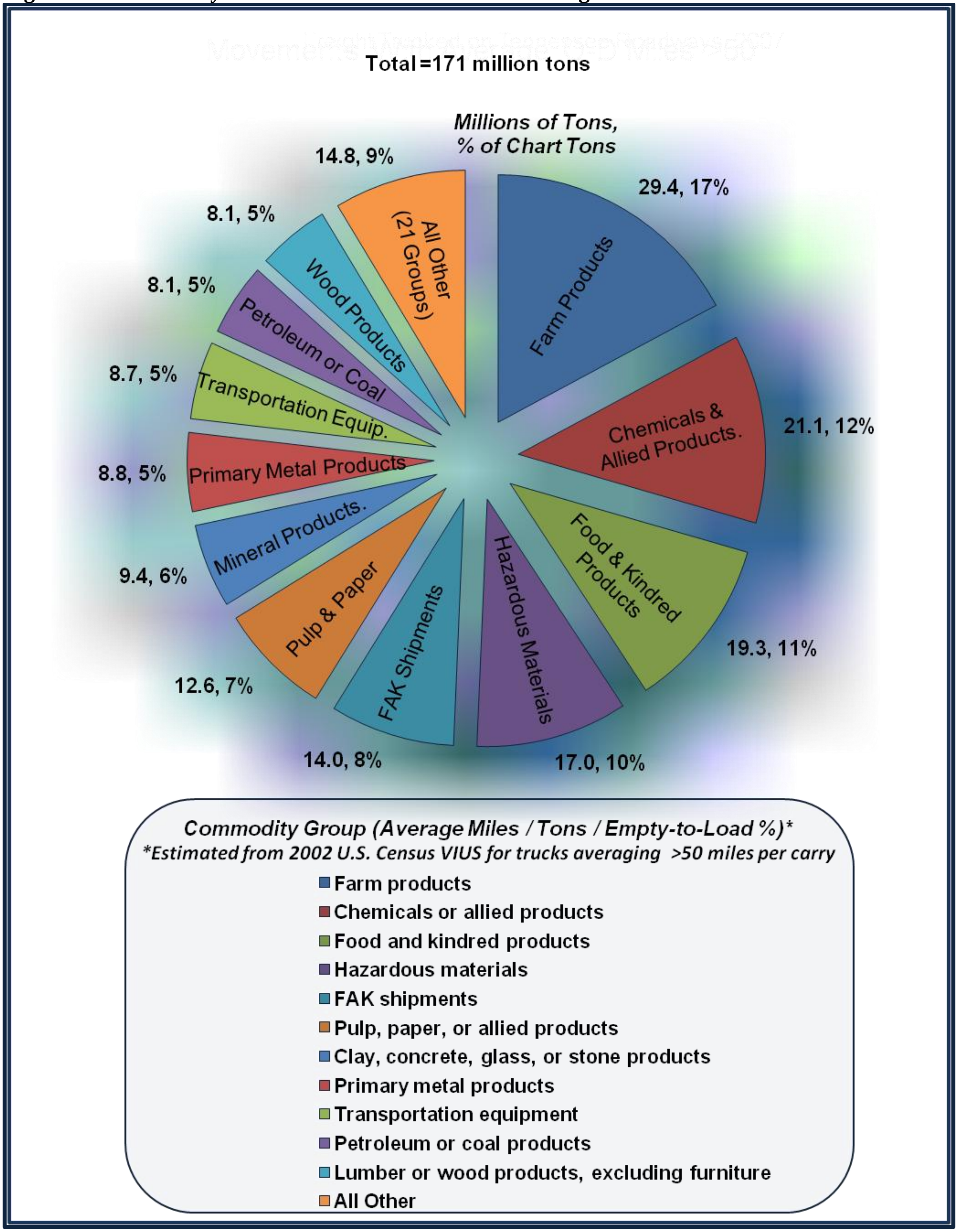


Figure 16: Commodity Distribution of Rail Traffic Excluding Coal



Rail Freight in Major Tennessee River Counties

The tables below show the top 10 commodity groupings railed into and out of the four Tennessee counties of interest for barge diversion where significant rail movements occur. Due to restrictions on the release of rail data, no numeric values can be provided. In every case, the top ten commodity groups account for over 90% of the tonnages moved by rail in and out of the county. **By far, Shelby County accounts for the most rail tonnages, both in and out.** The remaining outbound is fairly evenly divided between the other three counties. Hamilton has the second largest inbound, followed by Davidson, and, last, Knox.

Table 5: Top 10 Commodity Groups Railed Out of and In To Davidson County

Davidson Origin	Davidson Destination
FAK (freight, all kind) shipments	FAK (freight, all kind) shipments
Containers, carriers or devices, shipping, returned empty	Transportation equipment
Waste or scrap materials not id'd by producing industry	Chemicals or allied products
Chemicals or allied products	Clay, concrete, glass, or stone products
Hazardous Materials	Nonmetallic ores, minerals, excluding fuels
Rubber or miscellaneous plastics products	Hazardous Materials
Transportation equipment	Primary metal products
Electrical machinery, equipment, or supplies	Pulp, paper, or allied products
Printed matter	Food and kindred products
Apparel or other finished textile products or knit apparel	Lumber or wood products, excluding furniture

Table 6: Top 10 Commodity Groups Railed Out of and In To Hamilton County

Hamilton Origin	Hamilton Destination
Clay, concrete, glass, or stone products	Farm products
Food and kindred products	Food and kindred products
Farm products	Hazardous Materials
Chemicals or allied products	Chemicals or allied products
Waste or scrap materials not id'd by producing industry	Primary metal products
Pulp, paper, or allied products	Petroleum or coal products
Transportation equipment	Lumber or wood products, excluding furniture
Primary metal products	Clay, concrete, glass, or stone products
Machinery, excluding electrical	Pulp, paper, or allied products
Hazardous Materials	Transportation equipment

Table 7: Top 10 Commodity Groups Railed Out of and In To Knox County

Knox Origin	Knox Destination
Clay, concrete, glass, or stone products	Primary metal products
Primary metal products	Farm products
Chemicals or allied products	Clay, concrete, glass, or stone products
Food and kindred products	Hazardous Materials
Waste or scrap materials not id'd by producing industry	Waste or scrap materials not identified by producing industry
Transportation equipment	Lumber or wood products, excluding furniture
Waste Other Regulated Materials Group E	Food and kindred products
Lumber or wood products, excluding furniture	Petroleum or coal products
Pulp, paper, or allied products	Nonmetallic ores, minerals, excluding fuels
Fabricated metal products	Chemicals or allied products

Table 8: Top 10 Commodity Groups Railed Out of and In To Shelby County

Shelby Origin	Shelby Destination
FAK Shipments	FAK Shipments
Food and kindred products	Food and kindred products
Chemicals or allied products	Farm products
Transportation equipment	Chemicals or allied products

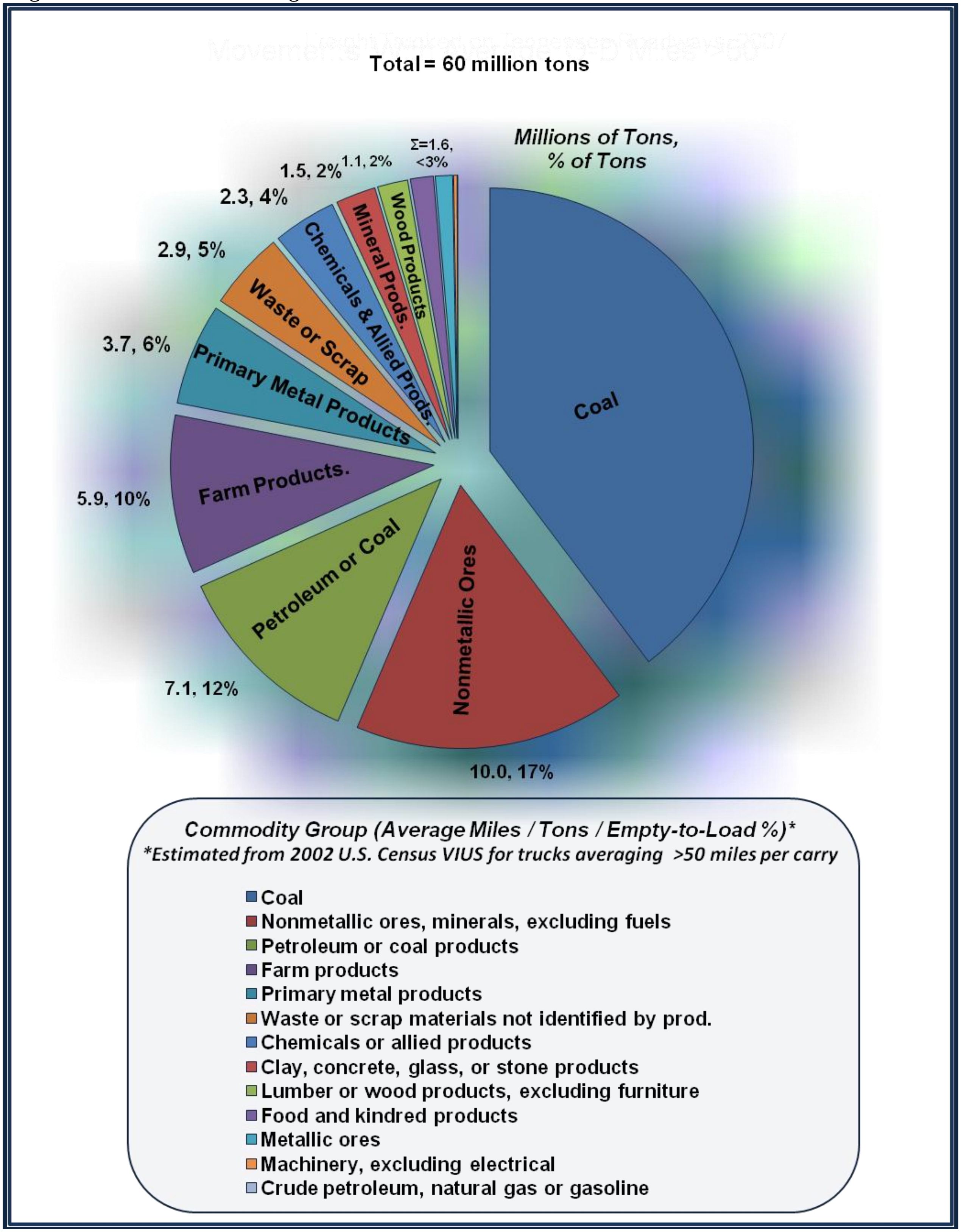
Shelby Origin	Shelby Destination
Hazardous Materials	Lumber or wood products, excluding furniture
Lumber or wood products, excluding furniture	Transportation equipment
Farm products	Hazardous Materials
Clay, concrete, glass, or stone products	Nonmetallic ores, minerals, excluding fuels
Primary metal products	Clay, concrete, glass, or stone products
Containers, carriers or devices, shipping, returned empty	Pulp, paper, or allied products

The chemicals or allied products group is found in the top ten of all eight categories (four counties, in and out). Food and kindred products are in seven, as is mineral products. The primary metal products group is in six, farm products in five, and pulp and related products in four. Any of these six groups could contain movements that might possibly be barged were the rates favorable. Davidson County has the least commonality among the four counties.

Barge Traffic

About 60 million tons of cargo is barged on the Cumberland, Tennessee, and tributaries to the Tennessee River. Of this, 23.8 million tons (40 percent) is coal traffic. Following coal, the tonnage in the major commodity groups measured in millions of tons is nonmetallic ores (10.0), petroleum or coal products (7.1), farm products (7.1), primary metals (3.7), chemicals (2.3), and lumber and wood (1.1). Petroleum and coal products include asphalt, which is very compatible with barge transportation due to the speed which it can be loaded to or from barges. The distribution of barge transportation is shown in Figure 17.

Figure 17: Distribution of Barge Traffic on Tennessee and Cumberland Rivers

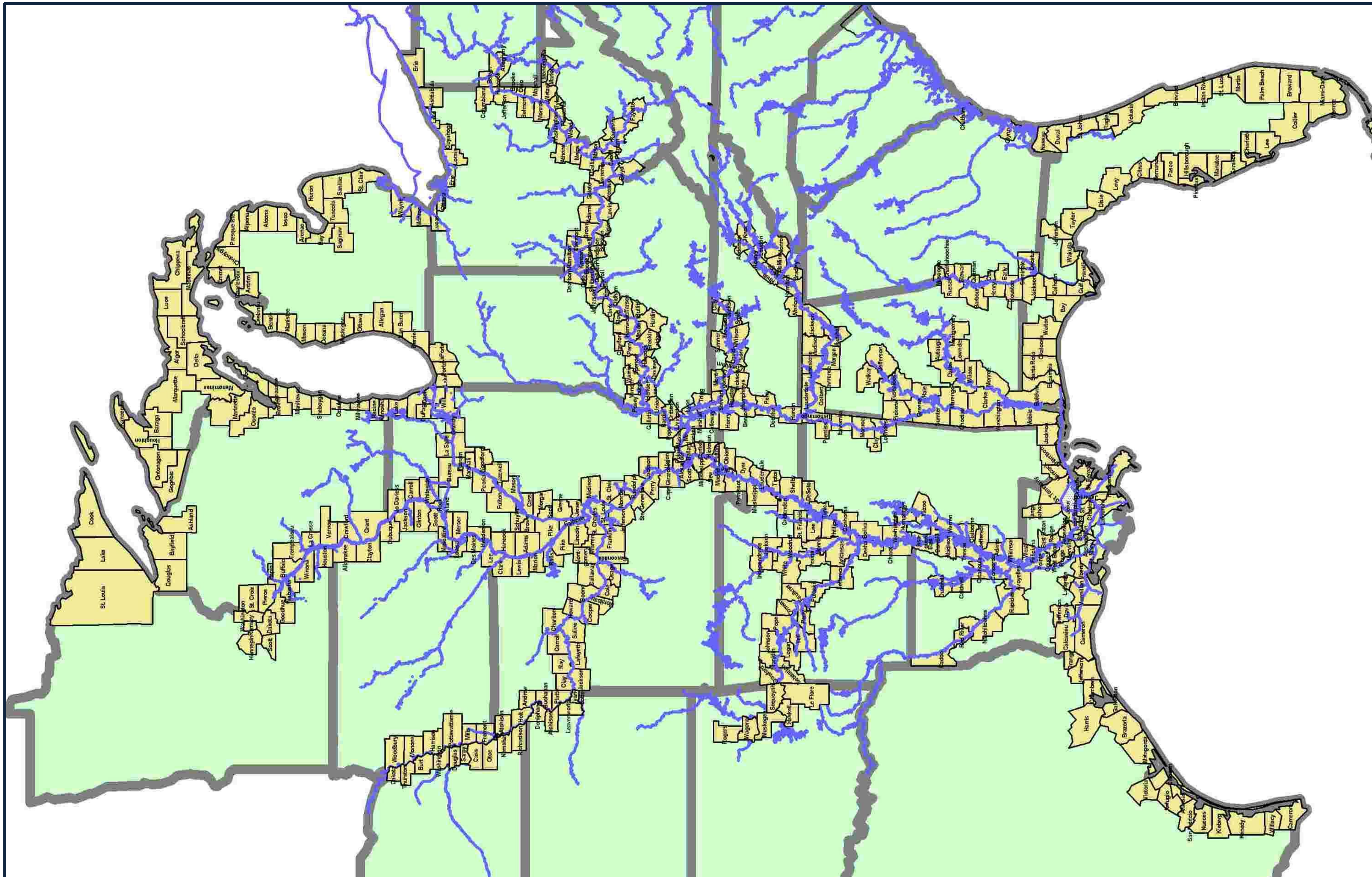


Data-Based Potential Diversions at STCC4-Level

Potentials within Navigable Waterway Corridor

CTR staff believes the commodity movements with the greatest potential for diversion to barge transportation in Tennessee are those that originate and terminate close to navigable waterways that run through the state, form the border of the state, or lie on the navigable waterways to the north and south of the state. The goal of this section of the report is to identify some of the more significant movements, refined to a more detailed, STCC4, commodity level. Figure 18 delineates the waterway counties.

Figure 18: Counties Bordering Navigable Waterways in and Around Tennessee



Truck Movements

Table 9 shows a summary of total truck freight—for all traffic with at least some portion of the movement lying within Tennessee—between all interconnected waterway counties where the summation of the traffic for each movement is greater than 150,000 tons. Ranked first among all commodity groups is broken stone or riprap with 14.1 million tons. If broken stone movements averaged 14 tons, in 2007 there were approximately 1 million shipments of broken stone that averaged about 20 miles, indicating many were very localized hauls (this would be the case even if the tons per load were somewhat higher).

Table 9: Truck Tonnages between Two Interconnected Navigable Waterway Counties

	Movements. >150,000 Tons	
STCC4 Commodity	Total Tons	Est. Total O-D Miles (One-way)
Broken Stone Or Riprap	14,090,524	19,516,326
Warehouse & Distribution Center	6,132,506	56,633,441
Rail Intermodal Drayage from Ramp	4,669,070	5,345,076
Rail Intermodal Drayage to Ramp	4,007,441	6,130,846
Gravel Or Sand	2,053,373	5,206,841
Metallic Ores	1,392,897	34,279,100
Air Freight Drayage from Airport	1,062,976	851,658
Air Freight Drayage to Airport	831,033	665,825
Ready-mix Concrete, Wet	464,488	475,599
Grain	279,640	722,317
Portland Cement	263,537	5,403,614
Nonmetal Minerals, Processed	179,114	152,261
Clay Ceramic Or Refrac. Minerals	178,683	470,405
Misc. Field Crops	175,334	3,627,385
Primary Iron Or Steel Products	161,030	2,475,146

Table 10 shows county-to-county truck freight from a Tennessee origin or to a Tennessee destination by STCC4 commodity codes, where there are at least 150,000 tons annually. Buried in these county-to-county data are likely to be some potential barge movements.

Table 10: Truck Shipments by Origin-Destination on Interconnected Waterway Counties

			Movements > 150,000 Tons	
STCC4 Commodity	Origin	Destination	Total Tons	Est. Total O-D Miles (One-way)
Rail Intermodal Drayage from Ramp	Shelby, TN	Shelby, TN	2,359,360	2,206,885
Broken Stone Or Riprap	Davidson, TN	Wilson, TN	2,248,227	1,905,094
Rail Intermodal Drayage to Ramp	Shelby, TN	Shelby, TN	1,890,750	2,774,647
Warehouse & Distribution Center	Shelby, TN	Shelby, TN	1,650,559	1,284,591
Rail Intermodal Drayage to Ramp	Shelby, TN	Crittenden, AR	1,502,602	2,541,685
Metallic Ores	Chatham, GA	Shelby, TN	1,392,897	34,279,100

			Movements > 150,000 Tons	
STCC4 Commodity	Origin	Destination	Total Tons	Est. Total O-D Miles (One-way)
Warehouse & Distribution Center	Hamilton, TN	Shelby, TN	1,327,249	21,898,884
Broken Stone Or Riprap	Knox, TN	Knox, TN	1,171,649	771,128
Broken Stone Or Riprap	Sumner, TN	Wilson, TN	1,168,232	884,211
Rail Intermodal Drayage from Ramp	Shelby, TN	Crittenden, AR	1,155,558	1,968,672
Broken Stone Or Riprap	Meigs, TN	Bradley, TN	1,077,532	558,483
Air Freight Drayage from Airport	Shelby, TN	Shelby, TN	1,062,976	851,658
Rail Intermodal Drayage from Ramp	Crittenden, AR	Shelby, TN	959,651	971,127
Broken Stone Or Riprap	Wilson, TN	Wilson, TN	938,921	617,957
Air Freight Drayage to Airport	Shelby, TN	Shelby, TN	831,033	665,825
Broken Stone Or Riprap	Shelby, TN	Shelby, TN	720,430	474,155
Broken Stone Or Riprap	Livingston, KY	Dyer, TN	670,201	3,148,328
Warehouse & Distribution Center	Shelby, TN	Hamilton, TN	636,034	10,494,221
Rail Intermodal Drayage to Ramp	Crittenden, AR	Shelby, TN	614,089	814,515
Warehouse & Distribution Center	Shelby, TN	Knox, TN	545,425	10,147,999
Broken Stone Or Riprap	Decatur, TN	Shelby, TN	530,942	2,653,584
Warehouse & Distribution Center	Hamilton, TN	Hamilton, TN	519,375	404,217
Broken Stone Or Riprap	Rhea, TN	Bradley, TN	469,547	1,012,091
Warehouse & Distribution Center	Shelby, TN	Davidson, TN	467,553	4,680,474
Warehouse & Distribution Center	Hamilton, TN	Knox, TN	441,105	2,248,625
Broken Stone Or Riprap	Cheatham, TN	Wilson, TN	403,043	618,400
Gravel Or Sand	Davidson, TN	Wilson, TN	389,830	330,333
Broken Stone Or Riprap	Bradley, TN	Bradley, TN	384,015	252,742
Warehouse & Distribution Center	Hamilton, TN	Davidson, TN	378,039	2,528,442
Gravel Or Sand	Humphreys, TN	Marshall, KY	369,179	1,272,593
Broken Stone Or Riprap	Hamilton, TN	Bradley, TN	360,805	390,334
Broken Stone Or Riprap	Montgomery, TN	Henry, TN	335,813	884,069
Broken Stone Or Riprap	Knox, TN	Anderson, TN	333,502	238,702
Broken Stone Or Riprap	Benton, TN	Henry, TN	318,633	56,360
Gravel Or Sand	Itawamba, MS	Shelby, TN	280,082	1,330,690
Grain	Tunica, MS	Shelby, TN	279,640	722,317
Broken Stone Or Riprap	Montgomery, TN	Wilson, TN	266,511	826,601
Broken Stone Or Riprap	Anderson, TN	Knox, TN	264,441	189,272
Portland Cement	Mobile, AL	Shelby, TN	263,537	5,403,614
Ready-mix Concrete, Wet	Shelby, TN	Shelby, TN	260,558	266,787
Broken Stone Or Riprap	Dickson, TN	Cheatham, TN	254,465	248,077
Broken Stone Or Riprap	Rhea, TN	Hamilton, TN	232,510	355,790
Broken Stone Or Riprap	Smith, TN	Wilson, TN	218,967	238,690
Broken Stone Or Riprap	Hamilton, TN	Hamilton, TN	218,099	143,544
Broken Stone Or Riprap	White, AR	Shelby, TN	212,403	1,010,890
Broken Stone Or Riprap	McMinn, TN	Bradley, TN	210,764	221,078
Broken Stone Or Riprap	Cheatham, TN	Cheatham, TN	204,715	134,735

			Movements > 150,000 Tons	
STCC4 Commodity	Origin	Destination	Total Tons	Est. Total O-D Miles (One-way)
Ready-mix Concrete, Wet	Davidson, TN	Davidson, TN	203,931	208,812
Rail Intermodal Drayage from Ramp	Shelby, TN	DeSoto, MS	194,502	198,392
Broken Stone Or Riprap	Montgomery, TN	Cheatham, TN	186,945	298,370
Gravel Or Sand	Davidson, TN	Davidson, TN	184,651	121,529
Nonmetal Minerals, Processed	Shelby, TN	Shelby, TN	179,114	152,261
Clay Ceramic Or Refrac. Minerals	Henry, TN	Montgomery, TN	178,683	470,405
Gravel Or Sand	Humphreys, TN	Cheatham, TN	176,954	333,377
Broken Stone Or Riprap	Benton, TN	Humphreys, TN	176,749	143,229
Broken Stone Or Riprap	Scott, MO	Dyer, TN	176,581	583,267
Broken Stone Or Riprap	Loudon, TN	Knox, TN	176,015	209,970
Misc. Field Crops	Loudon, TN	Chatham, GA	175,334	3,627,385
Gravel Or Sand	Perry, TN	Marshall, KY	173,856	695,842
Gravel Or Sand	Decatur, TN	Marshall, KY	172,935	675,798
Warehouse & Distribution Center	Shelby, TN	Bradley, TN	167,166	2,945,988
Primary Iron Or Steel Products	Jefferson, AL	Pulaski, AR	161,030	2,475,146
Broken Stone Or Riprap	Muhlenberg, KY	Wilson, TN	159,868	447,177
Gravel Or Sand	Tipton, TN	Shelby, TN	153,817	279,663
Gravel Or Sand	Davidson, TN	Sumner, TN	152,069	167,017

Based on these lists, the most promising commodity categories for barge diversion (ignoring any possibility of COB) of movements between interconnected waterway counties are likely to be broken stone or riprap and gravel or sand, followed by less common instances of shipments of metallic ores, processed non-metallic minerals, clay ceramic or refractory minerals, miscellaneous field crops, and primary iron or steel products.

Rail Movements

Table 10 shows a summary of larger rail freight tonnages—for all traffic with at least some portion of the movement lying within Tennessee—between all interconnected waterway counties. Ranked first among all commodity groups is hazardous materials with 6.0 million tons, followed by chemicals with 5.5 million tons and food and kindred products with 4.1 million tons. Chemicals are a high-valued good and food and kindred products are perishable. It is interesting that the mineral products group, which ranked high for truck transportation, are much less significant for rail.

Table 11: Total In or Thru Tennessee Rail Freight, All Interconnected Waterway Counties

STCC2 Commodity	Number of Movements	Tons	Miles	Avg. Tons	Avg. Miles
Hazardous Materials	79,008	5,960,236	65,784,080	75	833
Chemicals or allied products	60,615	5,490,043	58,068,210	91	958
Food and kindred products	56,856	4,077,552	50,169,390	72	882
FAK Shipments	281,160	3,783,440	223,279,960	13	794
Metallic ores	1,126	3,134,394	1,144,926	2,784	1,017
Primary metal products	33,132	2,963,352	24,915,041	89	752

STCC2 Commodity	Number of Movements	Tons	Miles	Avg. Tons	Avg. Miles
Pulp, paper, or allied products	55,868	2,762,572	50,573,506	49	905
Coal	357	2,664,920	253,859	7,465	711
Farm products	7,414	2,177,170	4,837,209	294	652
Transportation equipment	90,104	1,980,932	77,162,688	22	856
Clay, concrete, glass, or stone products	10,464	1,018,580	6,745,453	97	645
Waste or scrap materials not id'd by producing industry	15,668	955,660	12,032,453	61	768
Lumber or wood products, excluding furniture	10,612	598,968	6,044,724	56	570
Nonmetallic ores, minerals, excluding fuels	2,756	570,456	2,073,464	207	752
Petroleum or coal products	6,560	559,224	6,345,855	85	967
Containers, carriers or devices, shipping, ret. empty	76,320	534,560	60,283,228	7	790

Table 12 shows some of the larger county-to-county rail movements by STCC4 commodity codes. Buried in these county-to-county could possibly be some potential barge movements.

Table 12: Selected Large County-to-County Rail Movements In or Thru Tennessee

STCC2 Commodity	Origin	Destination
Metallic ores	St. Louis, MN	Jefferson, AL
Coal	Shelby, TN	Roane, TN
Chemicals or allied products	Harris, TX	Cook, IL
FAK Shipments	Cook, IL	Duval, FL
Coal	Jefferson, AL	Cook, IL
FAK Shipments	Cook, IL	Davidson, TN
FAK Shipments	Shelby, TN	Chatham, GA
Primary metal products	Lake, IN	Jefferson, AL
Hazardous Materials	Posey, IN	Lowndes, AL
Hazardous Materials	Harris, TX	Jefferson, KY
Farm products	Cook, IL	Hamilton, TN
Farm products	Cook, IL	Martin, FL
Transportation equipment	Wayne, MI	Duval, FL
Chemicals or allied products	Harris, TX	Shelby, TN
FAK Shipments	Hamilton, OH	Duval, FL
Nonmetallic ores, minerals, excl. fuels	Autauga, AL	Fayette, WV
Coal	Webster, KY	Jackson, AL
Food and kindred products	Cook, IL	Duval, FL
Coal	Monongalia, WV	Hernando, FL
Pulp, paper, or allied products	McMinn, TN	Chatham, GA
FAK Shipments	Duval, FL	Cook, IL
Coal	St. James, LA	Independence, AR
Hazardous Materials	Harris, TX	Shelby, TN
Food and kindred products	Manatee, FL	Hamilton, OH
FAK Shipments	Davidson, TN	Chatham, GA
FAK Shipments	Shelby, TN	Duval, FL

The diversion possibilities for rail to barge appear possibly somewhat diverse and include chemicals, food and kindred products, metallic ores, primary metal products, pulp and related products, coal, farm products, transportation equipment, mineral products, wood and related products, non-metallic ores, and petroleum or coal products.

Potentials between Multi-County Areas

Purpose and Methodology

This analysis expands upon the idea that potential barge movements are commodities shipped from waterway terminals located on a navigable stream to terminals also located on navigable streams. The idea is that certain commodities can be pooled or linked together to increase shipment volume so as to make the larger mass of goods more attractive as a potential barge commodity. In this exercise, each individual core origination-destination waterway county is combined with other counties' origin-destination counties that are located within a certain radius of the core origin-destination counties. In other words, this analysis investigates the numerical potential for larger-sized truck or rail freight diversions that could result from aggregating shipments from various producers or buyers in a multi-county region at dock facilities—were they to exist—located on the core waterway counties. No consideration is given in this analysis to either the current economic feasibility or current dock availability. This analysis is performed in a rigorous computer-based application with the sources being the rail waybill and Global Insight data bases.

The analysis is performed as follows:

First, we identify all counties on waterways (or coasts) that connect with the Tennessee, Cumberland and Mississippi Rivers, tributaries to the Tennessee River, and the Tennessee Tombigbee Waterway. These were shown in Figure 18. We refer to these counties as WWC (Waterway Counties). This is only done once and is used in all the analyses in this section.

1. By STCC four-digit commodity, for each WWC origin-destination pair in the movements database that has an origin or destination county on the Tennessee River, Cumberland River, or Tennessee-Tombigbee waterways (referred to as WWC*s), we identify the annual freight movement totals (either truck or rail) for all counties within a 30 or 50 mile radius of the WWC* (the distance is calculated using county population centroids). We refer to the county aggregations as WWR* (waterway regions). The larger WWR* flows are retained for further examination.
2. Calculate weighting factors for each county in each WWR*: (distance from waterway origin to waterway destination) divided by (sum of regional county distances to waterway origin and regional county distances to waterway destination. The weighting is based on the notion that the longer the port-to-port distance and the shorter origin or destination to port distance, the more likely is the movement to divert to barge.
3. Sum weighted tons, raw tons, and loads by WWR*s. The result is a large number of WWR*, many of which will overlap with one another in the set of counties they contain.
4. To eliminate many, if not most, of the cases where multiple WWR* contain much of the same freight movements, the WWR*s are programmatically analyzed one at a time, as follows:

a. Loop on WWR* (call selection WWR**)
    i. Get WWR** county components
    ii. Get all shared tons for all WWR* with overlapping counties
    iii. Calculate shared tons divided by total tons for all WWR*
    iv. Keep the WWR* or WWR** with largest total tons that contains at least 50% of shared tons
b. Next WWR*

5. After the completion of the iterative procedure, the duplicates in the set of WWR*s retained are eliminated.
6. The movements resulting from the automated procedure at this point are inspected for geographic feasibility to finally reduce the set of potential candidates to ones that appear to be reasonably feasible Tennessee traffic candidates for diversion to barge.

Diversion Potential Results

Truck-to-Barge

30-Mile Radius Waterway Regions

Shown in Table 13 are the truck diversion potentials for four-digit STCC commodity groups. Note that 24.5 percent of the potential diversions are accounted for by gravel and sand commodities.

Table 13: Truck Diversion Potentials by STCC4 Commodities from a Selected 30-Mile Area

Commodity	Tons
Asphalt Coatings Or Felt	84,244
Broken Stone Or Riprap	450,491
Concrete Products	81,892
Gravel Or Sand	1,009,427
Metallic Ores	576,127
Mineral Wool	125,599
Misc Plastic Products	69,324
Misc. Field Crops	496,033
Motor Vehicle Parts Or Accessories	184,088
Nonmetal Minerals, Processed	94,204
Portland Cement	870,206
Primary Forest Materials	79,813
Total ex. Warehouse & DC	4,121,448
Warehouse & Distribution Center	6,365,679
Grand Totals	10,487,127

Table 14 provides some specific movements by county of origin and county of destination.

Table 14: Selected Origin to Destination Movements for the 30-Mile Radius Truck Flows

Commodity	Tons	Origin Port	Dest Port	Port-Port Miles
Asphalt Coatings Or Felt	84,244	Loudon, TN	Pulaski, AR	457
Broken Stone Or Riprap	320,395	Houston, TN	Prentiss, MS	125
Broken Stone Or Riprap	130,097	Livingston, KY	Prentiss, MS	174
Concrete Products	81,892	Cheatham, TN	Tipton, TN	160
Gravel Or Sand	551,328	Hamilton, OH	Knox, TN	223
Gravel Or Sand	310,192	Monroe, MS	Tipton, TN	129
Gravel Or Sand	147,906	Marshall, AL	McMinn, TN	123
Metallic Ores	242,021	Chatham, GA	Cheatham, TN	449
Metallic Ores	222,834	Chatham, GA	Loudon, TN	316
Metallic Ores	111,273	Chatham, GA	Madison, AL	368
Mineral Wool	125,599	Wilson, TN	Oldham, KY	159
Misc Plastic Products	69,324	Loudon, TN	Tipton, TN	307
Misc. Field Crops	204,531	Limestone, AL	Tipton, TN	164
Misc. Field Crops	186,339	Monroe, TN	Chatham, GA	305
Misc. Field Crops	105,163	Dickson, TN	Tipton, TN	141
Motor Vehicle Parts Or Accessories	93,147	Davidson, TN	Tipton, TN	174
Motor Vehicle Parts Or Accessories	90,941	Loudon, TN	Tipton, TN	307
Nonmetal Minerals, Processed	94,204	Wilson, TN	Tipton, TN	194
Portland Cement	276,557	Mobile, AL	Tipton, TN	344
Portland Cement	175,996	Mobile, AL	Marion, TN	340
Portland Cement	160,004	Mobile, AL	Meade, KY	514
Portland Cement	116,920	Mobile, AL	Perry, TN	344
Portland Cement	72,132	Sumter, AL	Tipton, TN	219
Portland Cement	68,597	Mobile, AL	Cheatham, TN	390
Primary Forest Materials	79,813	Clay, TN	Tipton, TN	245
Warehouse & Distribution Center	1,407,279	Tipton, TN	Knox, TN	325
Warehouse & Distribution Center	1,376,665	Marion, TN	Tipton, TN	235
Warehouse & Distribution Center	1,007,228	Tipton, TN	Bradley, TN	276
Warehouse & Distribution Center	922,049	Tipton, TN	Davidson, TN	174
Warehouse & Distribution Center	337,402	Wilson, TN	Tipton, TN	194
Warehouse & Distribution Center	261,881	Wilson, TN	Knox, TN	136
Warehouse & Distribution Center	251,171	Davidson, TN	Tipton, TN	174
Warehouse & Distribution Center	188,536	Shelby, TN	Smith, TN	235
Warehouse & Distribution Center	140,999	Davidson, TN	Bradley, TN	126
Warehouse & Distribution Center	138,266	Shelby, TN	Montgomery, TN	173
Warehouse & Distribution Center	118,704	Loudon, TN	DeSoto, MS	325
Warehouse & Distribution Center	110,985	Marion, TN	Hardin, TN	148
Warehouse & Distribution Center	104,516	Marion, TN	Montgomery, TN	140

Figure 19-Figure 22 graphically depict the potential for some of the commodities that have potential to move by barge when in 2007 they moved by truck. The thickness of the arrows is a rough indicator of the relative tonnages among the movements.

Figure 20 shows some long stone movements taking place from the port of Mobile to Meade County, Kentucky and to Tipton and Marion County, Tennessee.

Figure 20 shows very significant transporting of metallic ores from the port of Savannah to Tennessee River waterway counties. Since these data were compiled, however, the movement from Savannah to Montgomery County, Tennessee has shifted sources and now moves from the upper Tennessee River to the zinc plant by water.

Figure 21 depicts some significant flows for concrete products, mineral wool, primary forest materials, non-metal processed minerals, asphalt coating or felt, and miscellaneous plastics products.

Figure 22 shows the distribution of warehousing and distribution traffic. The map shows some very large (as indicated by the thick arrows) movements of these commodities that traverse the state between distribution centers.

Figure 19: 30-Mile Region Truck Potentials for Mineral and Min. Prods.

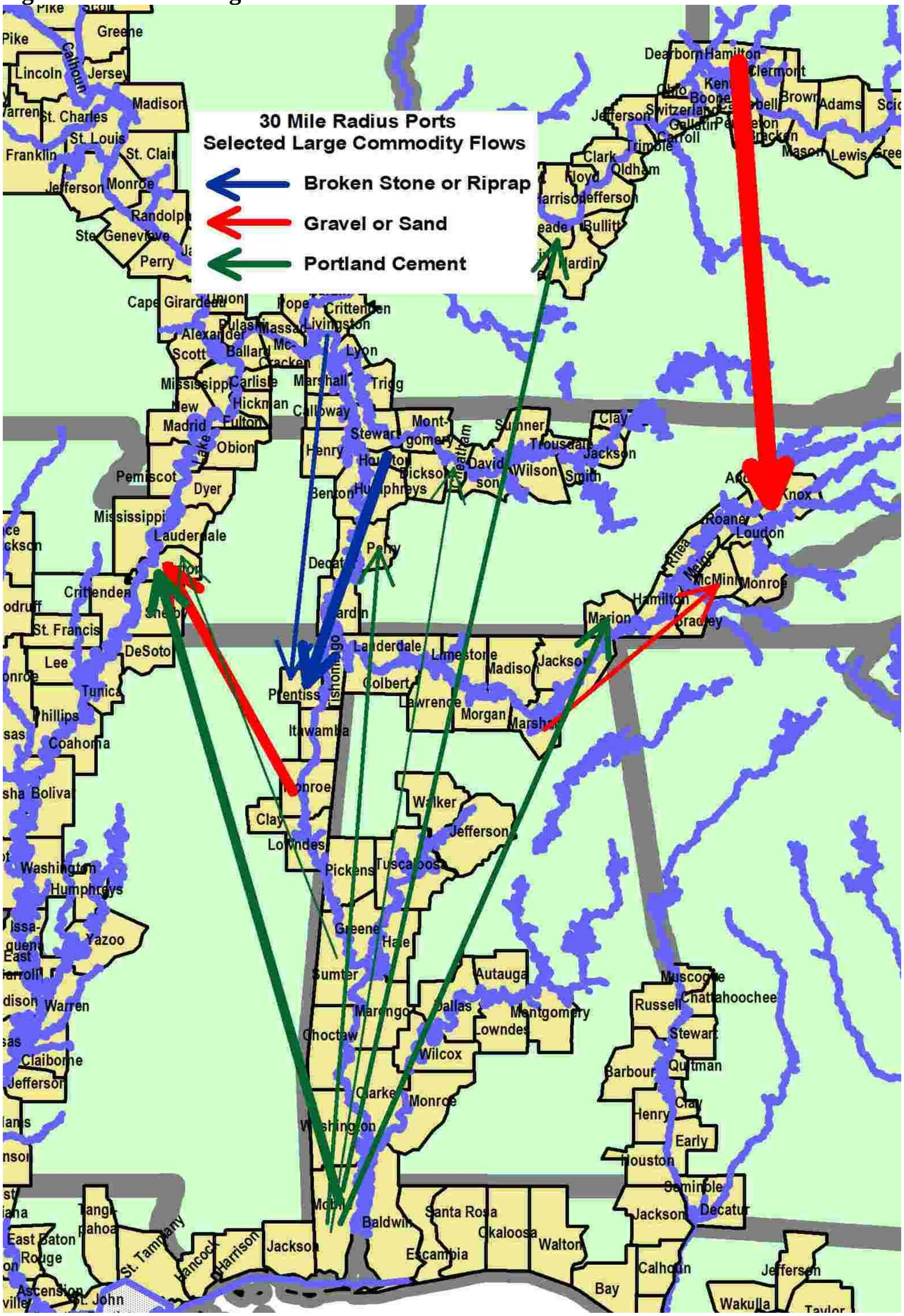


Figure 20: 30-Mile Region Truck Potentials for Metal Ores, Misc. Fld. Crops, and Mtr. Veh. Parts

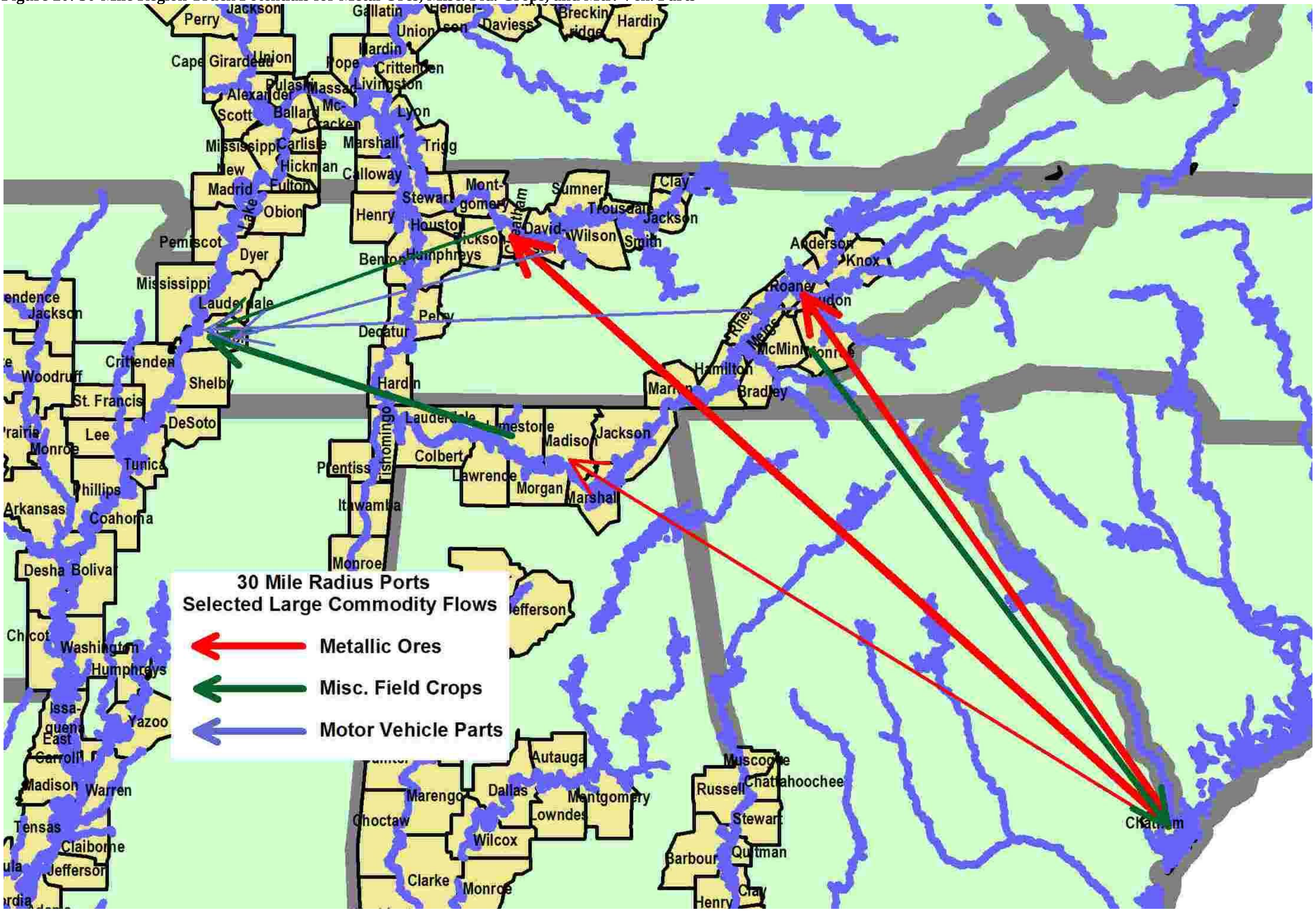


Figure 21: 30-Mile Region Truck Potentials for Miscellaneous Commodities

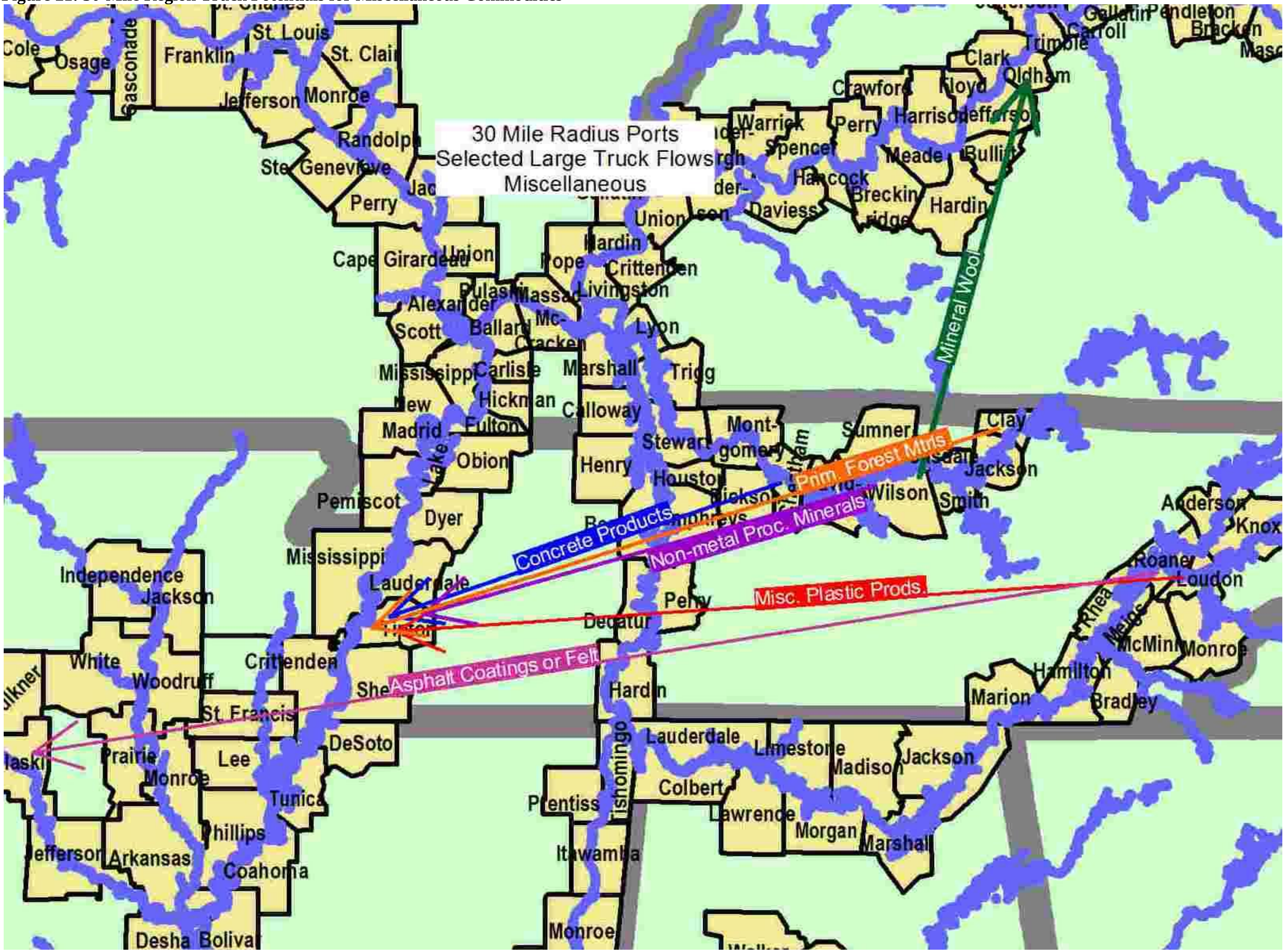
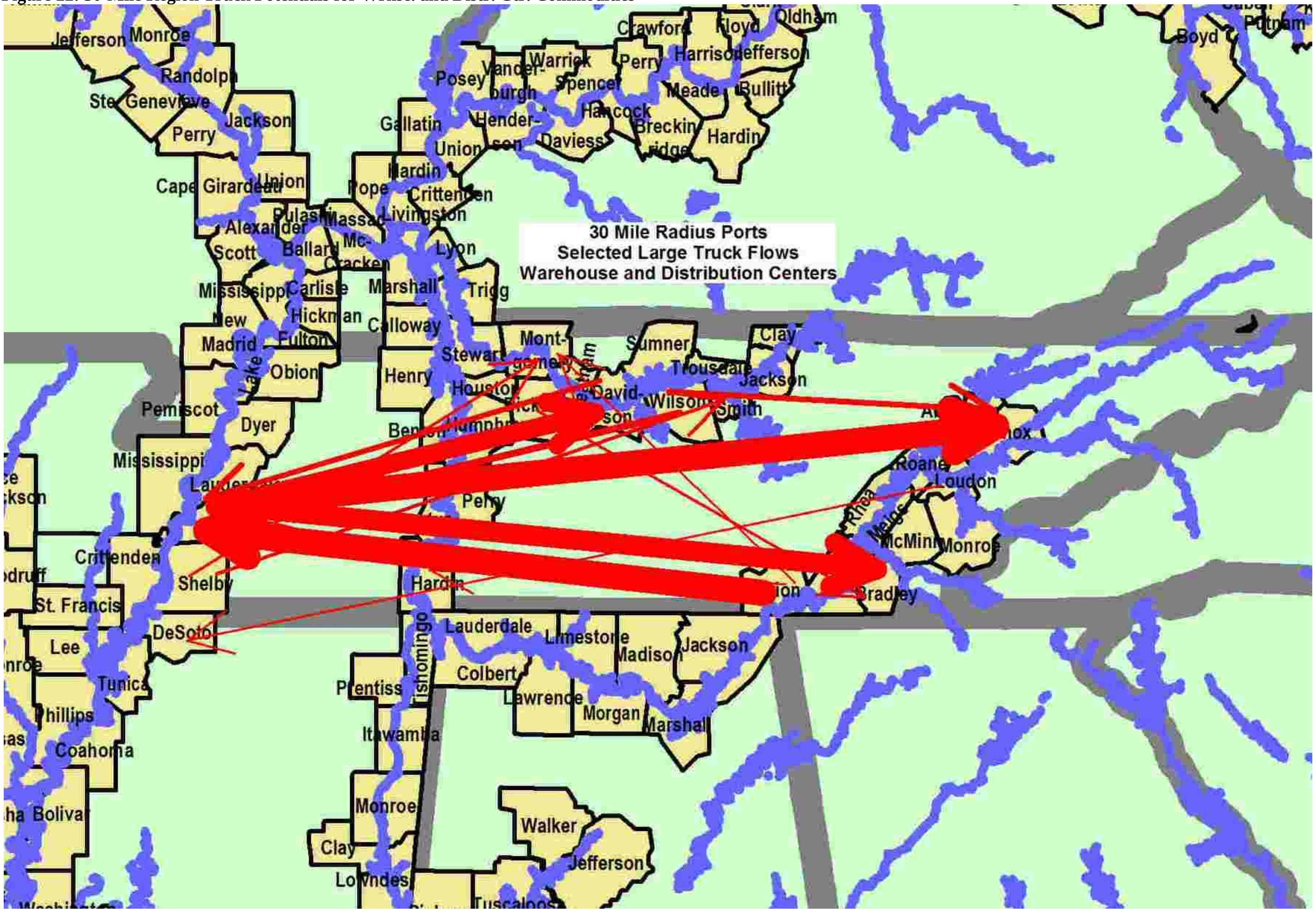


Figure 22: 30-Mile Region Truck Potentials for Wrhse. and Distr. Ctr. Commodities



50-Mile Radius Waterway Regions

Shown in Table 15 are the truck diversion potentials for four-digit STCC commodity groups. The two largest commodities, accounting for 52% percent of the potential diversion, are broken stone or riprap and Portland cement.

Table 15: Truck Diversion Potentials by STCC4 Commodities from a Selected 50-Mile Area

Commodity	Tons
Asphalt Coatings Or Felt	84,244
Broken Stone Or Riprap	2,104,270
Cyclic Intermediates Or Dyes	76,845
Gravel Or Sand	731,500
Gypsum Products	90,285
Metallic Ores	886,509
Misc Nonmetallic Minerals, NEC	138,739
Misc Plastic Products	76,104
Misc. Field Crops	194,470
Motor Vehicle Parts Or Accessories	98,832
Nonmetal Minerals, Processed	181,494
Portland Cement	1,011,084
Primary Forest Materials	244,357
Primary Iron Or Steel Products	90,701
Treated Wood Products	167,081
Total ex. Warehouse & DC	6,176,516
Warehouse & Distribution Center	5,875,357
Grand Total	12,051,872

Table 16 lists some specific movements by county of origin and county of destination.

Table 16: Selected Origin to Destination Movements for the 50-Mile Radius Truck Flows

Commodity Description	Tons	Origin Port	Destination Port	Port-Port Miles
Asphalt Coatings Or Felt	84,244	Roane, TN	White, AR	409
Broken Stone Or Riprap	615,212	Marshall, KY	Yazoo, MS	304
Broken Stone Or Riprap	435,147	Dickson, TN	Yazoo, MS	285
Broken Stone Or Riprap	190,687	Marion, TN	Yazoo, MS	316
Broken Stone Or Riprap	165,414	Massac, IL	Itawamba, MS	200
Broken Stone Or Riprap	162,412	Rhea, TN	Early, GA	292
Broken Stone Or Riprap	147,261	Cheatham, TN	Clay, MS	204
Broken Stone Or Riprap	120,634	Limestone, AL	Yazoo, MS	240
Broken Stone Or Riprap	109,534	Muhlenberg, KY	Itawamba, MS	215
Broken Stone Or Riprap	82,146	Marion, TN	Monroe, AL	268
Broken Stone Or Riprap	75,823	Hardin, TN	Yazoo, MS	205
Cyclic Intermediates Or Dyes	76,845	Lauderdale, TN	Mobile, AL	360
Gravel Or Sand	731,500	Hamilton, OH	Knox, TN	223

Commodity Description	Tons	Origin Port	Destination Port	Port-Port Miles
Gypsum Products	90,285	Carroll, KY	Marshall, AL	308
Metallic Ores	242,021	Chatham, GA	Sumner, TN	433
Metallic Ores	222,834	Chatham, GA	Roane, TN	331
Metallic Ores	172,281	Chatham, GA	Hardin, TN	464
Metallic Ores	138,101	Chatham, GA	Stewart, TN	491
Metallic Ores	111,273	Chatham, GA	Morgan, AL	377
Misc Nonmetallic Minerals, NEC	138,739	Yell, AR	Montgomery, TN	347
Misc Plastic Products	76,104	Roane, TN	Lauderdale, TN	281
Misc. Field Crops	194,470	Anderson, TN	Chatham, GA	331
Motor Vehicle Parts Or Accs.	98,832	Loudon, TN	Lauderdale, TN	295
Nonmetal Minerals, Processed	181,494	Knox, TN	Tipton, TN	325
Portland Cement	288,884	Mobile, AL	Tipton, TN	344
Portland Cement	177,408	Jackson, MS	Rhea, TN	414
Portland Cement	164,599	Mobile, AL	Oldham, KY	553
Portland Cement	116,027	Jackson, MS	Cheatham, TN	413
Portland Cement	96,636	Marshall, AL	Tipton, TN	211
Portland Cement	93,120	Mobile, AL	Muhlenberg, KY	456
Portland Cement	74,409	Sumter, AL	Tipton, TN	219
Primary Forest Materials	129,053	Jackson, TN	Tipton, TN	238
Primary Forest Materials	115,305	Roane, TN	Lauderdale, TN	281
Primary Iron Or Steel Products	90,701	Morgan, AL	Pulaski, AR	306
Treated Wood Products	88,889	Anderson, TN	Lauderdale, TN	301
Treated Wood Products	78,192	Smith, TN	Lauderdale, TN	203
Warehouse & Distribution Center	1,736,782	Lauderdale, TN	Loudon, TN	295
Warehouse & Distribution Center	1,681,680	Jackson, AL	Lauderdale, TN	215
Warehouse & Distribution Center	1,301,683	Tunica, MS	McMinn, TN	330
Warehouse & Distribution Center	335,204	Tipton, TN	Jackson, TN	238
Warehouse & Distribution Center	311,425	Rhea, TN	Dyer, TN	249
Warehouse & Distribution Center	211,311	Jackson, AL	Fulton, KY	214
Warehouse & Distribution Center	150,656	Yazoo, MS	Loudon, TN	403
Warehouse & Distribution Center	146,615	Dyer, TN	Hamilton, OH	342

Figure 23-Figure 26 graphically depict the flows for some of the commodities that appear to have the most potential, based on 50-mile radius regions, to divert from truck to barge. The thickness of the arrows is, again, a rough indicator of the relative tonnages among the movements.

Some commodity flows illustrated between these 50-mile radius aggregated waterway regions on the maps include some large movements of broken stone or riprap into mid-western Mississippi, some gravel or sand to East Tennessee shipments, and some very large movements of warehouse and distribution goods moving, primarily, east and west across Tennessee. There are also, as with the 30-mile regions, several significant movements of metallic ores from the port of Savannah to Tennessee River waterway counties.

Figure 23: 50-Mile Region Truck Potentials for Minerals and Min. Prods.

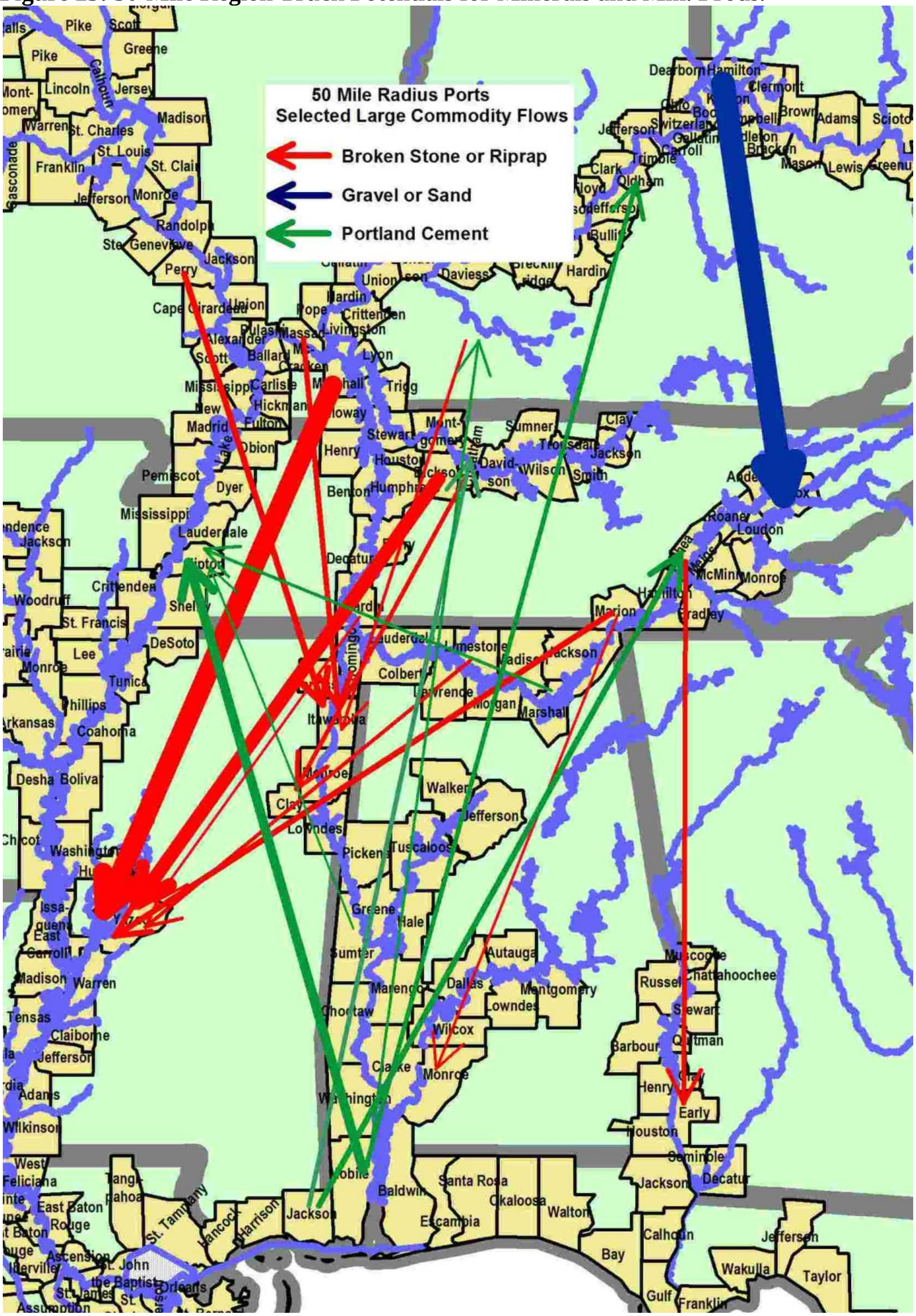


Figure 24: 50-Mile Region Truck Potentials for Metallic Ores, Misc. and Processed Nonmetals

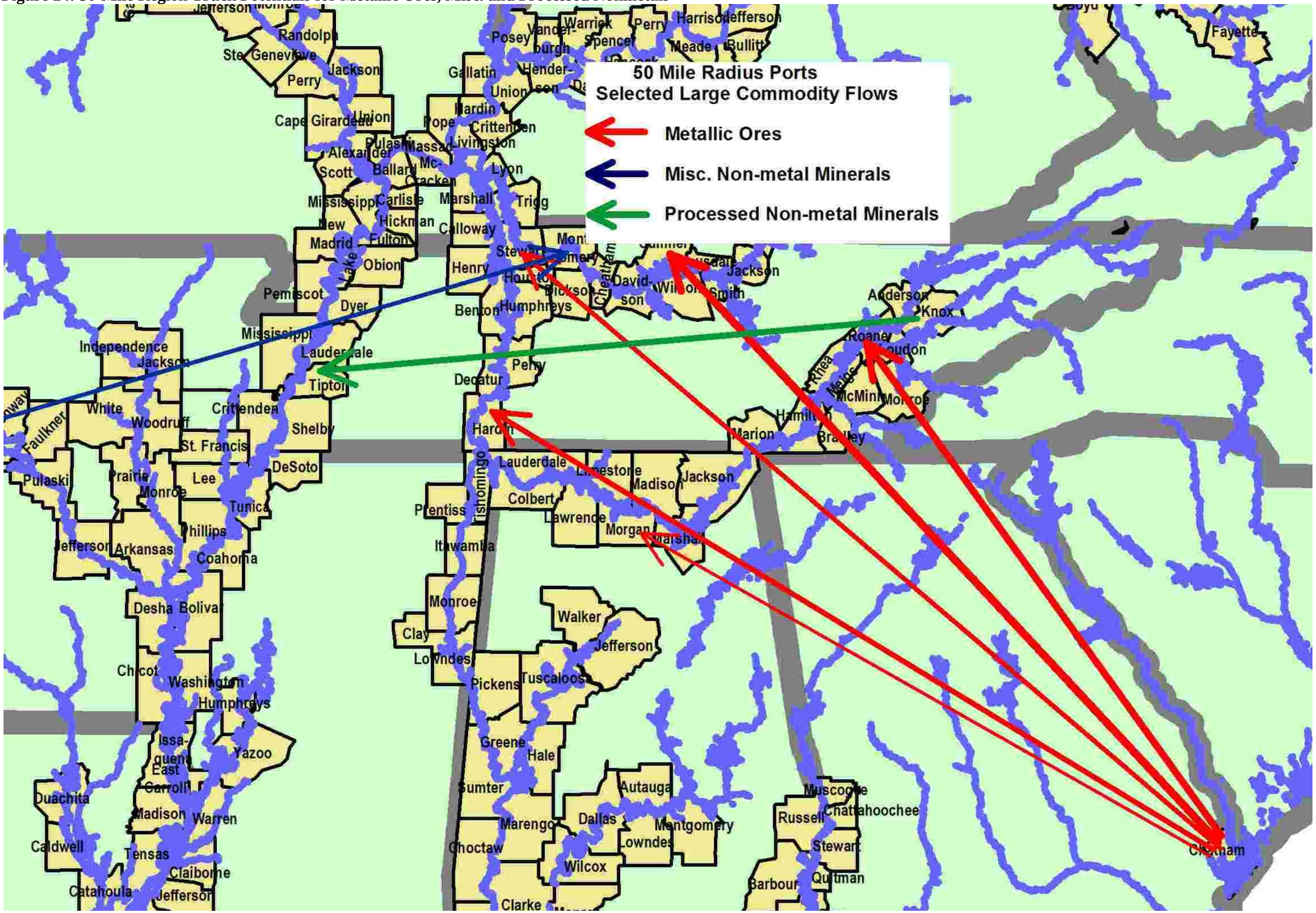


Figure 25: 50-Mile Region Truck Potentials for Miscellaneous Commodities

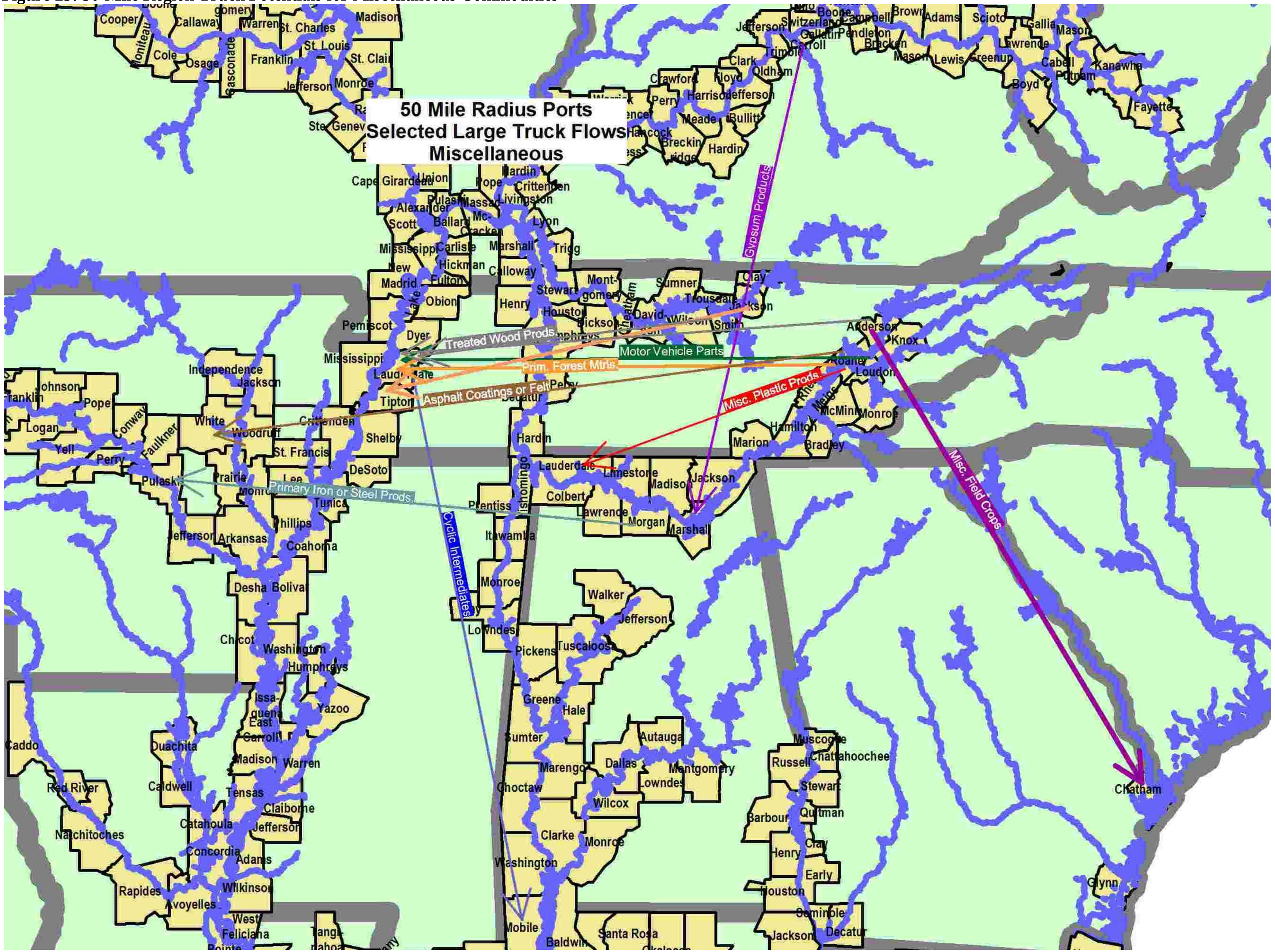
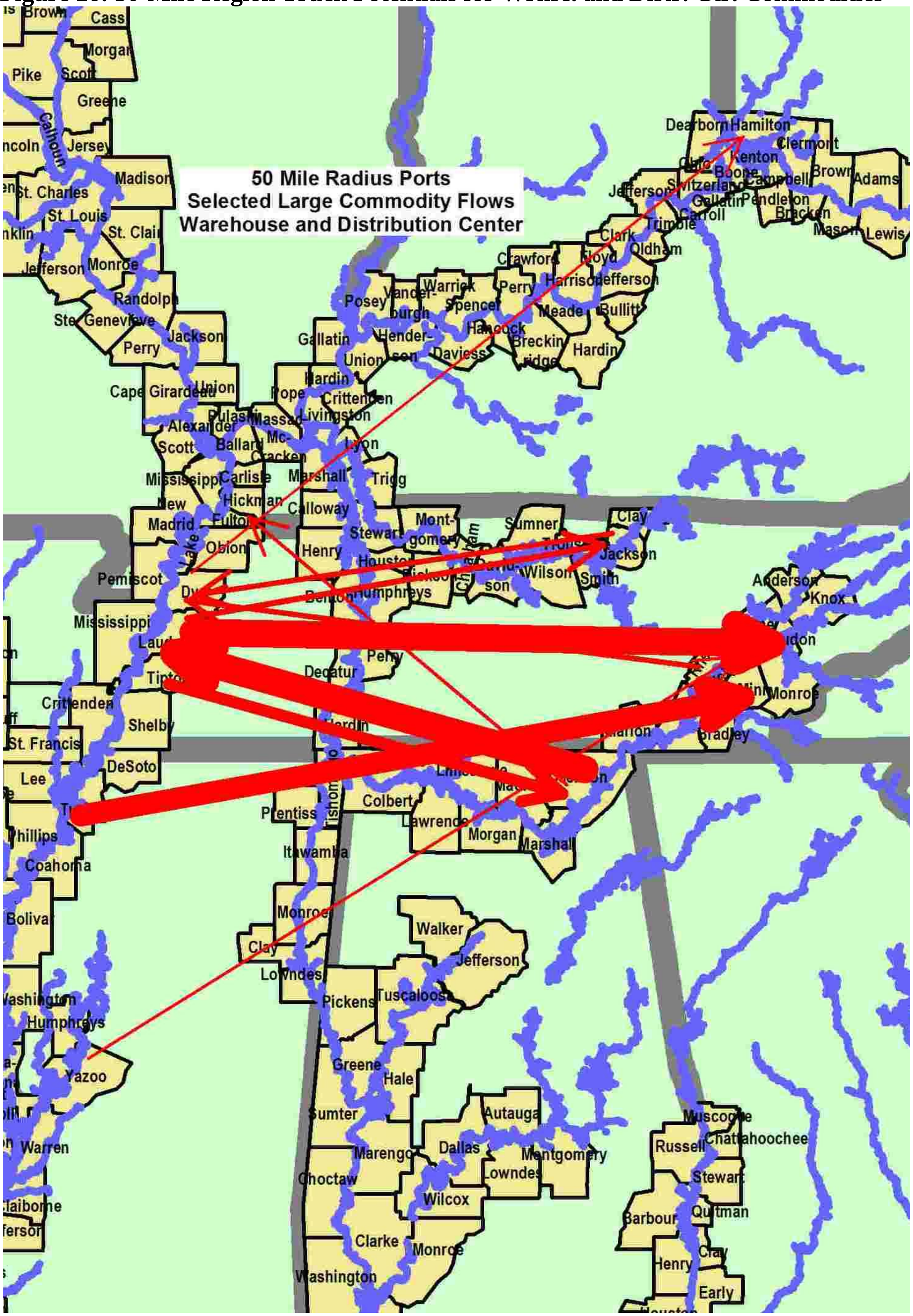


Figure 26: 50-Mile Region Truck Potentials for Wrhse. and Distr. Ctr. Commodities



Rail-to-Barge (50-Mile Radius Regions)

For rail-to-barge, only 50-mile radius regions are examined due to the longer typical distances for rail transport. Table 17 shows the potential candidate rail-to-barge county-to-county rail movements. Actual tonnages are not provided because of data disclosure restrictions.

Table 17: 50-Mile Radius County-to-County Candidate Rail Movements

STCC4 Commodity	Origin Port	Destination Port
Bauxite Or Other Alum Ores	Victoria, TX	McMinn, TN
Bauxite Or Other Alum Ores	West Baton Rouge, LA	Hamilton, TN
Broken Stone Or Riprap	Hardin, TN	Tipton, TN
Broken Stone Or Riprap	Stewart, TN	Yazoo, MS
Cottonseed Oil Or By-prod	Tipton, TN	Hardin, TN
Fiber, Paper Or Pulpboard	Hamilton, TN	Kenosha, WI
Fiber, Paper Or Pulpboard	Lowndes, AL	Sumner, TN
Fiber, Paper Or Pulpboard	Natchitoches, LA	Morgan, AL
Flour Or Other Grain Mill Products	Webster, KY	Sumner, TN
Grain	Carroll, KY	McMinn, TN
Grain	Dyer, TN	St. Tammany, LA
Grain	Dyer, TN	Tangipahoa, LA
Grain	Erie, OH	Monroe, TN
Grain	Grundy, IL	Mobile, AL
Grain	Henry, TN	Jackson, MS
Grain	LaPorte, IN	Jackson, AL
Grain	LaPorte, IN	Madison, AL
Grain	Lauderdale, TN	Rhea, TN
Grain	Lucas, OH	McMinn, TN
Grain	Montgomery, TN	Jackson, AL
Grain	Montgomery, TN	Madison, AL
Grain	Ottawa, OH	Hamilton, TN
Grain	Ottawa, OH	McMinn, TN
Grain	Porter, IN	Jackson, AL
Grain	Porter, IN	Madison, AL
Grain	Porter, IN	Mobile, AL
Grain	Posey, IN	Jackson, AL
Grain	Posey, IN	McMinn, TN
Grain	Posey, IN	Morgan, AL
Grain	St. Louis, MO	Rhea, TN
Gravel Or Sand	Muscogee, GA	Stewart, TN
Gravel Or Sand	Stewart, TN	Sumner, TN
Lime Or Lime Plaster	Roane, TN	Bradley, TN
Metal Scrap Or Tailings	Ray, MO	Dyer, TN
Metal Scrap Or Tailings	Rogers, OK	Dyer, TN
Metal Scrap Or Tailings	St. Louis, MO	Dyer, TN

STCC4 Commodity	Origin Port	Destination Port
Metal Scrap Or Tailings	Sumner, TN	Oldham, KY
Misc Coal Or Petroleum Products	Lyon, KY	St. Johns, FL
Misc Coal Or Petroleum Products	Webster, KY	Hamilton, TN
Misc Industrial Organic Chemicals	Harris, TX	McMinn, TN
Misc Industrial Organic Chemicals	Morgan, AL	Wood, WV
Misc Mixed Shipments, NEC	Chatham, GA	Sumner, TN
Misc Mixed Shipments, NEC	Kenosha, WI	Sumner, TN
Misc Mixed Shipments, NEC	Morgan, AL	Tipton, TN
Misc Mixed Shipments, NEC	Sumner, TN	Chatham, GA
Misc Mixed Shipments, NEC	Sumner, TN	Kenosha, WI
Misc Mixed Shipments, NEC	Tipton, TN	Morgan, AL
Motor Vehicle Parts Or Accessories	Montgomery, TN	St. Louis, MO
Motor Vehicle Parts Or Accessories	Sumner, TN	Oldham, KY
Motor Vehicles	Davidson, TN	Orleans, NY
Motor Vehicles	Monroe, MI	Sumner, TN
Motor Vehicles	Sumner, TN	Tipton, TN
Motor Vehicles	Tipton, TN	Sumner, TN
Nonmetal Minerals, Processed	Hamilton, TN	Porter, IN
Nonmetal Minerals, Processed	Henry, TN	Tipton, TN
Nonmetal Minerals, Processed	Knox, TN	Chatham, GA
Nonmetal Minerals, Processed	Putnam, GA	Roane, TN
Nonmetal Minerals, Processed	Roane, TN	Putnam, GA
Nonmetal Minerals, Processed	Roane, TN	Sumter, AL
Nonmetal Minerals, Processed	St. Clair, IL	Pickens, AL
Nonmetal Minerals, Processed	Ste. Genevieve, MO	Mobile, AL
Nonmetal Minerals, Processed	White, AR	Greene, AL
Oil Kernels, Nuts Or Seeds	Adams, OH	Mobile, AL
Oil Kernels, Nuts Or Seeds	Dyer, TN	Tangipahoa, LA
Oil Kernels, Nuts Or Seeds	Hamilton, OH	Morgan, AL
Oil Kernels, Nuts Or Seeds	Lucas, OH	Mobile, AL
Oil Kernels, Nuts Or Seeds	Lucas, OH	Morgan, AL
Oil Kernels, Nuts Or Seeds	Ottawa, OH	Morgan, AL
Oil Kernels, Nuts Or Seeds	Porter, IN	Morgan, AL
Oil Kernels, Nuts Or Seeds	Van Buren, MI	Mobile, AL
Oil Kernels, Nuts Or Seeds	Warrick, IN	Morgan, AL
Paper	Marengo, AL	Lake, IN
Passenger Motor Car Bodies	Sumner, TN	Oldham, KY
Plastic Mater Or Synth Fibres	Assumption, LA	McMinn, TN
Plastic Mater Or Synth Fibres	Hancock, MS	McMinn, TN
Plastic Mater Or Synth Fibres	Hancock, MS	Rhea, TN
Plastic Mater Or Synth Fibres	Harris, TX	Hamilton, TN
Plastic Mater Or Synth Fibres	Harris, TX	Sumner, TN
Plastic Mater Or Synth Fibres	St. John the Baptist, LA	McMinn, TN

STCC4 Commodity	Origin Port	Destination Port
Plastic Mater Or Synth Fibres	Tangipahoa, LA	Hamilton, TN
Plastic Mater Or Synth Fibres	Wayne, WV	McMinn, TN
Plastic Mater Or Synth Fibres	West Baton Rouge, LA	Prentiss, MS
Portland Cement	Hancock, WV	Morgan, AL
Portland Cement	Rhea, TN	Knox, TN
Portland Cement	Rhea, TN	Santa Rosa, FL
Portland Cement	Sumter, AL	Jackson, MS
Potassium Or Sodium Compound	Lake, IN	Knox, TN
Potassium Or Sodium Compound	Lake, IN	Monroe, TN
Primary Forest Materials	Benton, TN	Ohio, KY
Primary Forest Materials	Putnam, GA	Hardin, TN
Primary Forest Materials	Putnam, GA	Roane, TN
Primary Forest Materials	Stewart, TN	Scioto, OH
Primary Iron Or Steel Products	Cuyahoga, OH	Sumner, TN
Primary Iron Or Steel Products	Dyer, TN	Harris, TX
Primary Iron Or Steel Products	Dyer, TN	Rogers, OK
Primary Iron Or Steel Products	Dyer, TN	San Patricio, TX
Primary Iron Or Steel Products	Hamilton, OH	Roane, TN
Primary Iron Or Steel Products	Hamilton, OH	Sumner, TN
Primary Iron Or Steel Products	Hancock, WV	Sumner, TN
Primary Iron Or Steel Products	Porter, IN	Lauderdale, AL
Primary Iron Or Steel Products	Roane, TN	Kenosha, WI
Primary Iron Or Steel Products	Tangipahoa, LA	Roane, TN
Pulp Or Pulp Mill Products	Calloway, KY	Tipton, TN
Pulp Or Pulp Mill Products	Clarke, AL	Brown, WI
Pulp Or Pulp Mill Products	Mobile, AL	Manitowoc, WI
Pulp Or Pulp Mill Products	Mobile, AL	Scott, MO
Pulp Or Pulp Mill Products	Rhea, TN	Chatham, GA
Pulp Or Pulp Mill Products	Washington, AL	Oconto, WI
Pulp Or Pulp Mill Products	Washington, AL	Ohio, KY
Railroad Cars	Tipton, TN	Morgan, AL
Semi-trailers Returned Empty	Morgan, AL	Tipton, TN
Semi-trailers Returned Empty	Sumner, TN	Chatham, GA
Semi-trailers Returned Empty	Sumner, TN	Kenosha, WI
Soybean Oil Or By-products	Morgan, AL	Rhea, TN
Soybean Oil Or By-products	Webster, KY	Jackson, AL
Sugar, Refined, Cane Or Beet	Hancock, MS	Rhea, TN
Sugar, Refined, Cane Or Beet	Lee, FL	Rhea, TN
Wet Corn Milling Or Milo	Kenosha, WI	Hamilton, TN
Wet Corn Milling Or Milo	Morgan, AL	Lauderdale, TN
Wet Corn Milling Or Milo	Roane, TN	Indian River, FL
Wet Corn Milling Or Milo	Tipton, TN	Morgan, AL

Table 18: Summary of Rail 50-Mile Rail Selections by STCC4 Commodity

Commodity Description	Total Tons	Total Shipments	Total Estimated Miles
Bauxite Or Other Alum Ores	401,376	4,040	3,230,240
Broken Stone Or Riprap	615,524	6,224	1,558,772
Cottonseed Oil Or By-prod	50,160	560	49,280
Fiber, Paper Or Pulpboard	200,160	3,160	1,333,240
Flour Or Other Grain Mill Products	54,080	560	55,440
Grain	2,980,674	28,683	11,442,719
Gravel Or Sand	137,184	1,380	262,920
Lime Or Lime Plaster	66,828	684	36,252
Metal Scrap Or Tailings	255,088	2,896	761,068
Misc Coal Or Petroleum Products	1,776,066	15,156	3,848,787
Misc Industrial Organic Chemicals	141,920	1,440	922,080
Misc Mixed Shipments, NEC	947,520	68,680	24,288,840
Motor Vehicle Parts Or Accessories	207,280	3,600	655,680
Motor Vehicles	500,160	23,360	7,066,240
Nonmetal Minerals, Processed	674,920	6,840	2,112,800
Oil Kernels, Nuts Or Seeds	777,940	7,800	4,089,671
Paper	54,040	680	432,480
Passenger Motor Car Bodies	68,760	680	101,320
Plastic Mater Or Synth Fibres	924,788	9,900	4,732,960
Portland Cement	323,280	2,960	743,200
Potassium Or Sodium Compound	311,920	3,108	1,373,024
Primary Forest Materials	312,920	3,472	690,096
Primary Iron Or Steel Products	943,320	10,400	4,878,920
Pulp Or Pulp Mill Products	683,360	8,520	5,213,640
Railroad Cars	52,040	1,744	301,712
Semi-trailers Returned Empty	144,880	24,080	9,105,840
Soybean Oil Or By-products	267,268	2,748	494,112
Sugar, Refined, Cane Or Beet	152,160	1,560	845,320
Wet Corn Milling Or Milo	313,680	3,280	1,162,560

Some larger movements from one of the 50-mile regions to another are shown in Figure 27-

Figure 30. **Some of the more significant aggregated rail flows shown include:**

- **large farm and farm products shipments from the Great Lakes into East Tennessee and North Alabama**
- **miscellaneous coal or petroleum products from the Ohio River to southeastern Tennessee**
- **broken stone or riprap from the northern Tennessee River area to mid-western Mississippi**
- **bauxite or other aluminum ores and plastics or synthetic fibers from the Texas Gulf to southeastern Tennessee**
- **potassium or sodium compounds from the Great Lakes to East Tennessee**
- **miscellaneous mixed shipments from the Great Lakes to north-central Tennessee**

Figure 27: 50-Mile Regions Rail Potentials for Farm and Farm Products

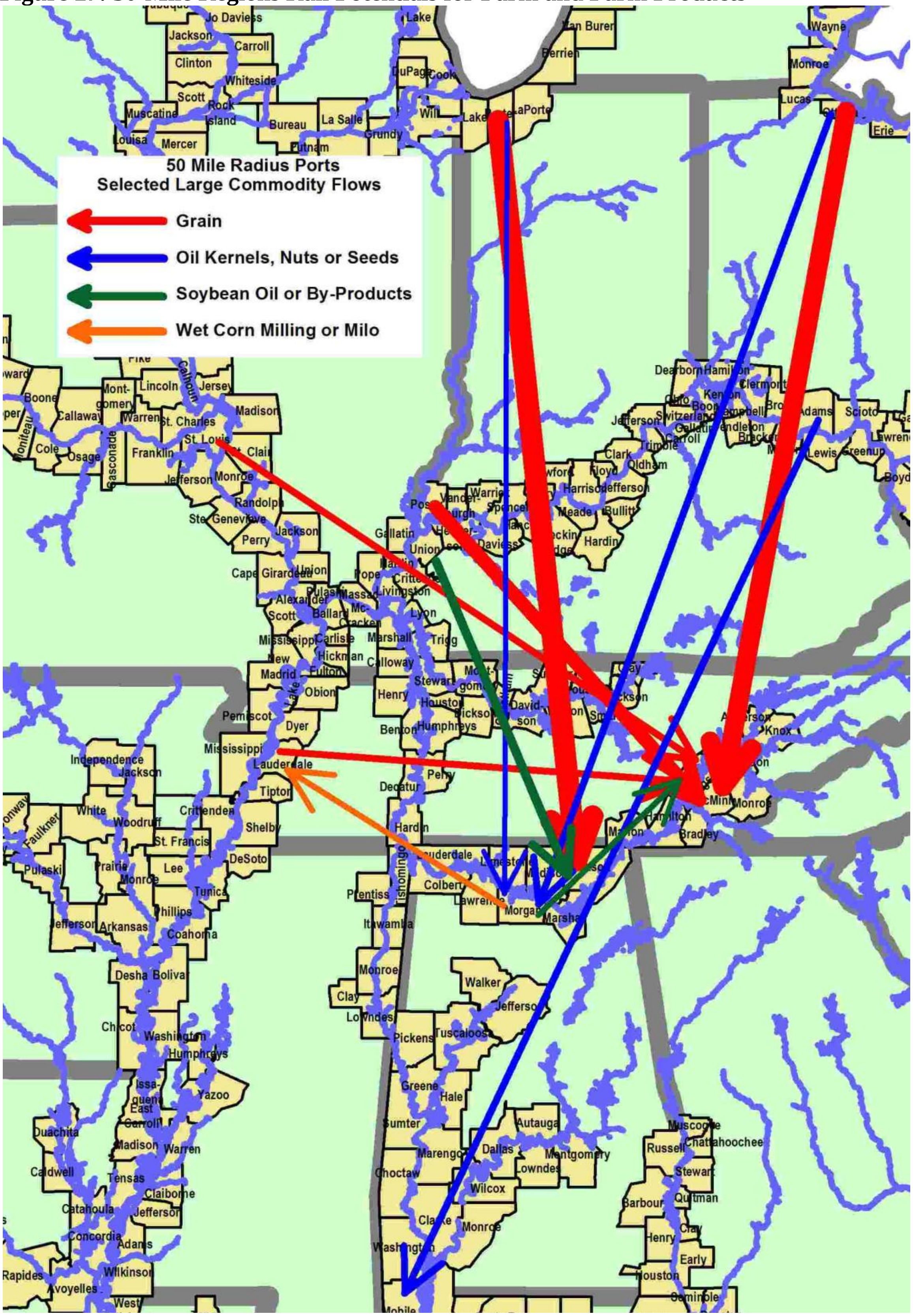


Figure 28: 50-Mile Regions Rail Potentials for Minerals and Min. Products

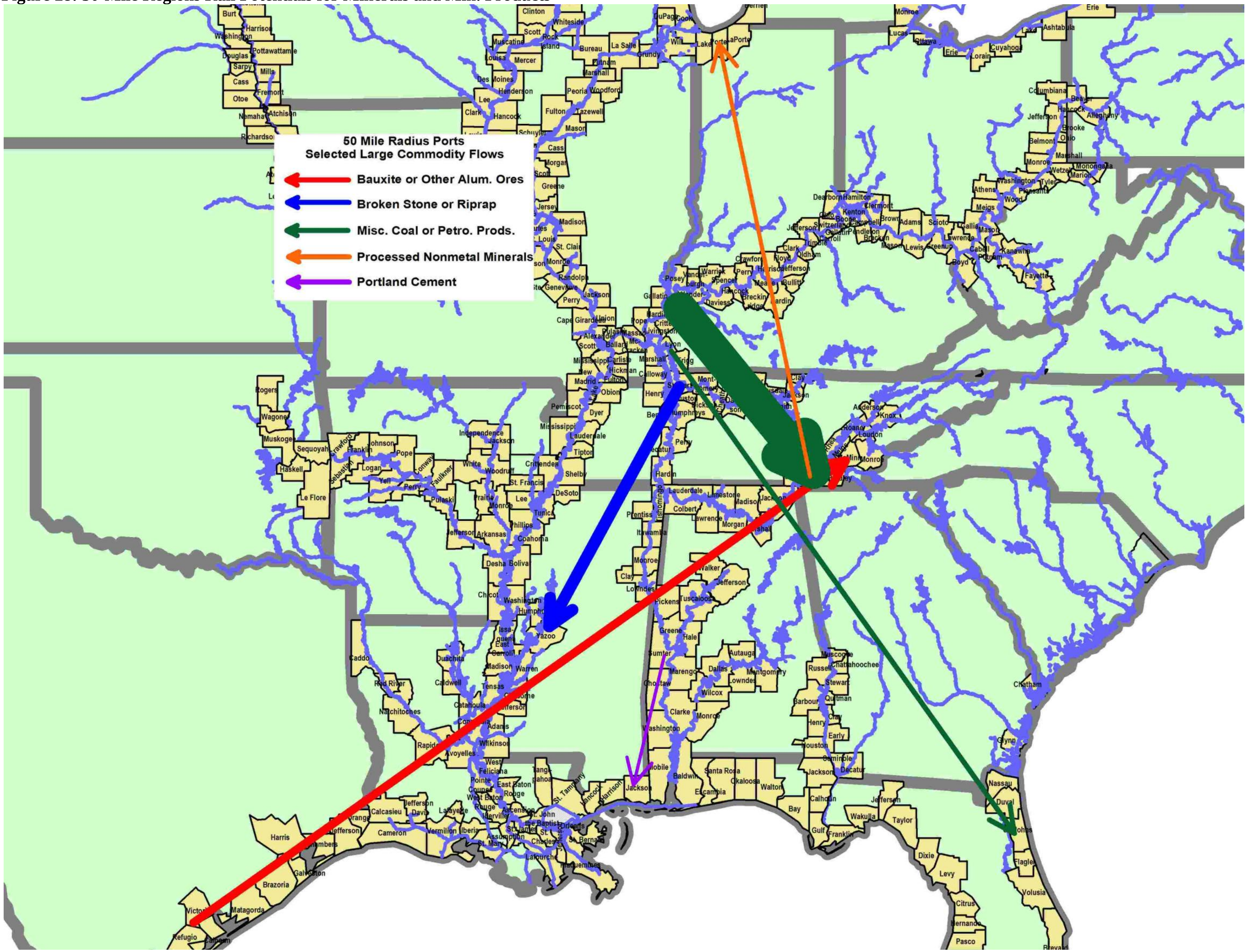


Figure 29: 50-Mile Regions Rail Potentials for Plastics, Chemical, Woods

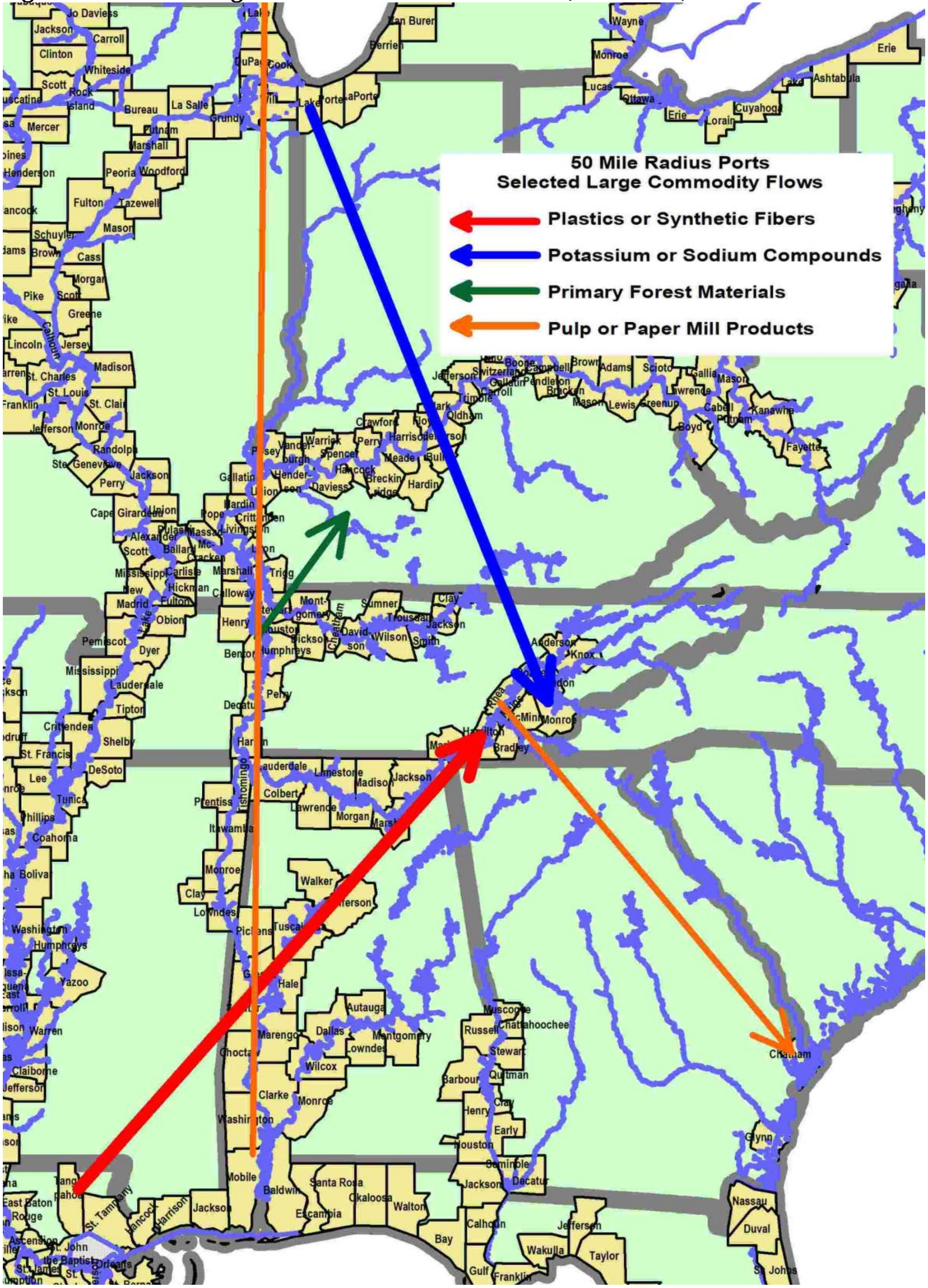
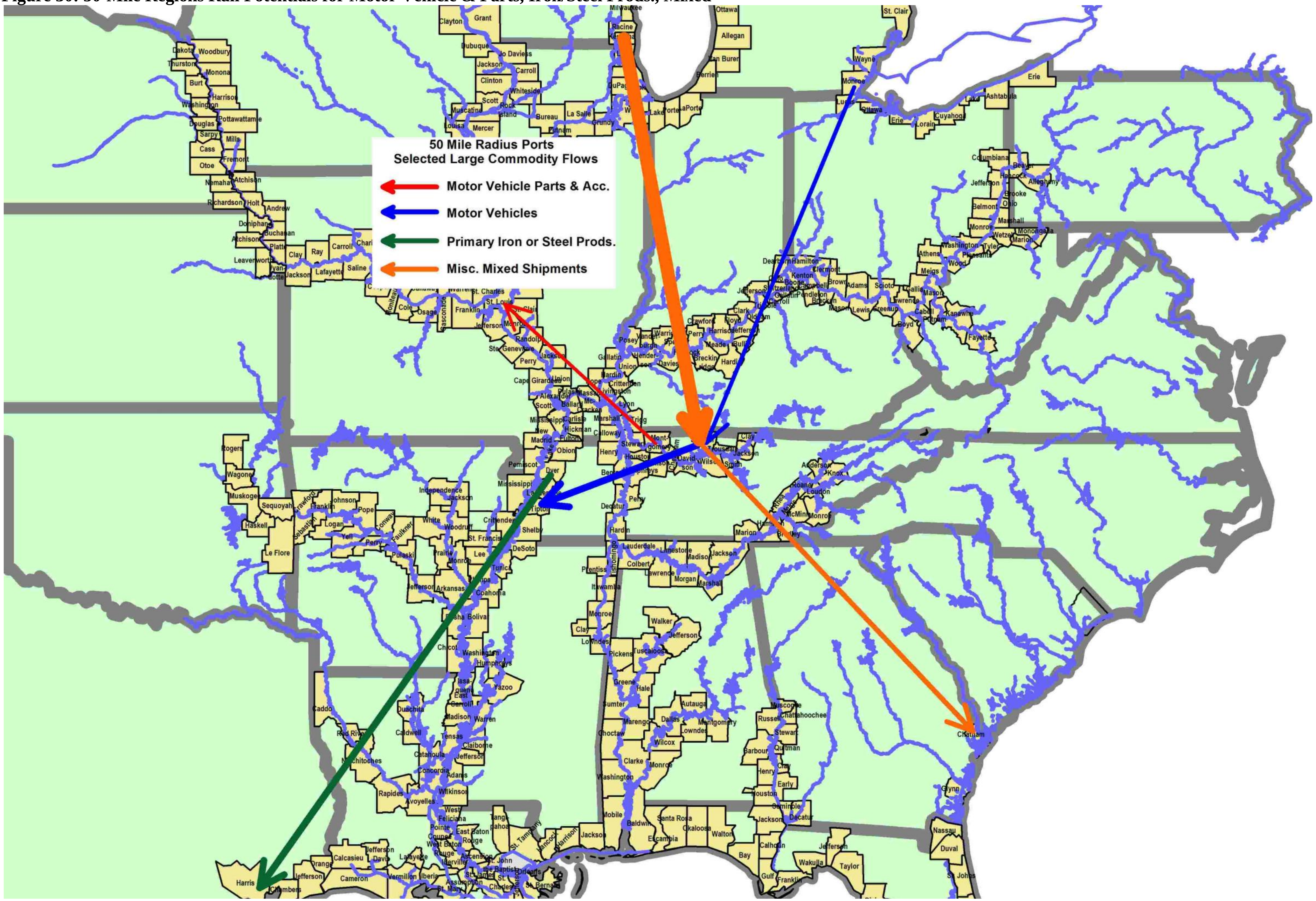


Figure 30: 50-Mile Regions Rail Potentials for Motor Vehicle & Parts, Iron/Steel Prods., Mixed



Field Research – Diversion Information from Interviews

Over the past nine months the CTR has interviewed about 30 shippers, carriers, or port directors regarding their thoughts on at least one leg of an overland movement shifting to barge transportation. In turn, these people had interviewed other shippers, and they were kind enough to share their information with us. Thus, CTR has built a very rich file from which to discuss the likelihood that certain commodities could conceivably be shifted to barge transportation. These commodities fall primarily in the categories of general container-on-barge, high value goods, liquids, coal, and dry bulk cargo.

Diversion Possibilities by Traffic Types

Container-on-Barge

General Container-on-Barge

The feasibility of a widespread penetration of container-on-barge (COB) to the inland river system can be examined from the standpoint of the shipper or carrier who might consider making the change to COB or from that of a planner who views the system and sees no other option given high forecast traffic growth rates. But, from either perspective, it is instructive to study where COB has been tried and, especially, where it is working or has worked successfully.

An early successful application of COB was in Memphis with the maiden voyage occurring on March 2, 1994. The Kirby Corporation owned the company America's Marine Express which operated the Panimax 12 foot draft vessel *Baltimar Euros*. This vessel could be loaded to 280 twenty foot equivalent units (TEUs)[10] and operated on a 14 day schedule between Memphis and Mexico and Guatemala carrying cotton for the textile mills in South America. It operated for about six months and ended due to European financiers pulling out of the project. The project had reached a breakeven point at the time of closure[11].

Another example is the approximate 40-year use of COB in the island economies. Containers are used because of the geographic captivity of islands. In addition, coastal short sea shipping of containers has been used to expand the geographic reach of the island vessel operators.

The Congestion and Mitigation and Air Quality Program (CMAQ) Improvement Program provides a flexible funding source to state and local governments to help meet the requirements of the Clean Air Act. CMAQ can be used to support transportation projects that reduce mobile source emissions in areas in noncompliance with U.S. Environmental Protection Agency standards. Intermodal activities are projects that can be supported by CMAQ funds, among others such as idle reduction projects.

An example of the use of CMAQ funds was at Red Hook, which is a cocoa port in Brooklyn, New York. Here, the cocoa from Africa and South America is off loaded, fumigated at the Red Hook

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[10] A standard 40x8x8 container equals 2 TEUs dimensioned as 20x8x8.
[11] Randy Richardson, Director of the Port of Memphis, in a telephone interview September 2, 2010.

terminal, and transported in rail floats or container barges across the harbor. Using CMAQ money, the Port Authority has been subsidizing container-on-barge transport across the harbor for years following its inception in 1991. The subsidization was justified as mitigation for the reconstruction of the Gowanus Expressway and operates to relieve truck traffic on congested highways and promotes international trade. The Gowanus Expressway is still under construction[12]. The barge service at this private terminal has continued to operate through the years and at the present time is not being subsidized[13].

Along the Gulf Coast, a vessel operator has established a container-on-barge service in conjunction with three steamship lines. Over 90% of the operator's revenue comes from either overweight or empty container positioning. Here the overweight containers cannot legally travel over state or federal highways, requiring a local dray on county or local roads. The positioning of empties is a result of excess containers being shifted to the port of last call of the steamship line by the least cost method.

Another example use of container-on-barge is along the Columbia-Snake waterway. Here refrigerated containers containing fresh onions, potatoes and frozen vegetables destined for Asia are typically loaded to over 60,000 pounds net weight. These overweight containers are prohibited on state and federal highways; however, local counties have recruited vegetable processing plants and general commodity docks to locate in industrial parks adjacent to the waterway.

The last use of container-on-barge is the periodic, but irregular, repositioning of empty containers from Lower Mississippi River and Lower Ohio River ports to New Orleans. The moves reflect using non-time sensitive and low-cost transportation for the move to the port of last call.

The Port of Pittsburgh[14] was the closest to actually facilitating a container-on-barge movement in the eastern U.S. inland river system. Their potential client was U. S. Steel, but the movement never happened for two reasons. First, shippers who use the just-in-time" supply chain delivery system are comfortable with this system, and container-on-barge is a diversion from their comfort zones. The port found significant turnover at the corporate level where the authority resided to make significant shifts in corporate strategy, and the managers were reluctant to make any changes. Second, while negotiating with the logistics managers, the price of steel increased. Because the containers are manufactured from steel, the steamship lines which own the containers became very possessive of their property. Before the price rise, the owners had no problem with the containers moving inland and returning, for example, very slowly by barge carriage. But when the price of steel rose, the opportunity cost to the steamship lines rose, and they began charging demurrage, or rent, on the boxes, and, if the idea of container-on-barge was not already dead, the demurrage charge killed it.

[12] Roberta Wesibrod, Director of the Partnership for Sustainable Ports, in a telephone interview of September 7, 2010.
[13] Information provided by Dr. Roberta Wesibrod in an email.
[14] This information was provided by Jim McCarVille, April 19, 2010 in Huntington, West Virginia.

The Wal-Mart Corporation has also been contracted by the port director at the Port of Henderson County about using COB. A representative explained that Wal-Mart's normal distribution plan is to receive containers in Houston at their facility. They unload containers, warehouse, and reconfigure outbound trucks loads heading from their inland distribution centers. They were not interested in shipping full containers as they often contain only one product. They make a point of receiving them in Houston so they can sort, warehouse, and reconfigure truck loads specific to market demand. They did have some interest in exploring how to use the river to bring their trucks and trailers back to Houston as most are returning empty after they make their inland delivery. Doing this would require facilities of a new type—drive-on barge and roll-on and roll-off (ro-ro)—constructed up and down the river system, as well as, somewhere in the Houston area.[15]

Panama Canal Container Diversion

The capacity of the Panama Canal will be doubled with the completion of the new chamber in 2014. MARAD forecasts that the new lock chamber will result in a large proportion of the growing container shipment market diverting to an all-water routing from Asian manufacturers to Gulf Coast and Eastern U.S. ports for distribution. Many in the southeast view this diversion as an opportunity for the containers to be shipped to inland distribution centers by COB. Some are making plans to accommodate this increase in barge traffic.

The impacts of modernizing the Panama Canal are, therefore, important to state highway planners, since the flow of containers in the southeast could change. The expansion of the Panama Canal, when completed in 2014, will double its capacity. The new capacity will allow the canal to accommodate ships built to carry 12,600 TEU containers, up from a ceiling of 4,400 TEUs locking today. It is expected that 8.4 million TEUs will transit the canal in 2015, as compared to 6.6 million expected in 2010[16].

Container traffic in the United States has been forecast by MARAD to geographically shift by about 17% with the opening of the expanded canal. Additionally, MARAD forecasts that container traffic will increase by 6 to 8 percent annually. State planners are interested in the distribution and growth of this traffic and want to know if this increase in containers will continue to enter the U.S. through West Coast ports or, with greater Panama Canal capacity, will the increase follow an all water route from Asia to Gulf and eastern U.S. ports? Currently, about 70% of Asian container imports to the U.S.[17] move through the eight (six in the U.S.) container ports on the West Coast. This number is down from 80% in the 1990s[18]. There is speculation that, with the completion of the expansion of the Panama Canal in 2014, West Coast container traffic will drop even further as a portion of it diverts to an all water route to the Gulf and eastern U.S. terminals. The cause of the declines include

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[15] This information was provided by Greg Pritchett in an email dated July 27, 2010.
[16] Soloman, Mark B. *DC Velocity*, "Panama Project Threatens West Coast Ports' Lock on Asian Trade," October 4, 2009.
[17] Soloman. Here it is reported that 60% to container traffic is handled at West Coast ports.
[18] Mongelluzzo, Bill. "West Coast Ports Emphasize Competitive Edge," *The Journal of Commerce Online*, March 31, 2010.

the labor problems that occurred in October of 2002 (the 10 day lock out of labor that delayed Christmas orders), the battle over the constitutionality of the ports' clean air plans, taxes and fees, congestion, and the shift in Asian production to the Southeast.

For those who study the subject, the capacity of the lock is just about all that can be agreed upon. Solomon reports that Jones Lang LaSalle Inc. argues for a 25% reduction of West Coast container traffic due to congestion at the West Coast ports and competition between East Coast ports for the business. It is interesting that Drewry Shipping Consultants in London also projected as much as a 25% market shift[19]. But, in contrast, Soloman also cites a source that predicts only a 10% decline in containers at the West Coast ports, with 5% already having occurred since the 2005-2007 peaks. The reasoning behind the lower loss figure lies in (1) a favorable geographic proximity of West Coast ports to Asian production, (2) the ability of railroads to slash rates to keep their container traffic, and (3) service times. It is simply faster to move the containers to the West Coast, transload them to rail, and ship them on to their destinations, as compared to an all water Suez Canal or Panama Canal route.

Others have weighed in on the possibility that the fervor around the potential boon to the Gulf States has been overblown. Among these is Stephen Moret, the Louisiana Economic Development Secretary, who argues that expanding the Panama Canal will not "…ignite a bonanza for shipping containers at Gulf ports."[20] Moret predicts an increase of 6 to 7 percent in Louisiana container traffic. He argues that western US ports gain an advantage because they are near large population centers. Further, "bottle necking" is an inherent assumption in the higher diversion estimates. It turns out that West Coast ports have "more than enough capacity" to meet their increased demands. Robert Landry, market director at the Port of New Orleans, is reported to feel that capacity is not an issue at the West Coast ports; rather he argues that increasing fees and taxes will drive traffic away from the West Coast.[21] Reported in the *Journal of Commerce Online*[22], industry predictions earlier in the decade that Los Angeles-Long Beach would reach capacity around 2010 now appear to be way out of line as the ports have resumed expansion of marine terminal and intermodal facilities and have extended their gate hours.

Additionally, those who use the lock will be expected to pay for the lock expansion which in US dollars is approximately $5.25 billion plus interest. In an attempt to raise capital, toll charges on seven of the ten types of vessels have recently risen by between 6.5 to 14 percent, while charges based on displacement tons have increased 9 percent. Mr. Edmund Brookes of the British Chamber

[19] Mongelluzzo, Bill, "Infrastructure Limits Shift to East Coast Ports: Study," *The Journal of Commerce Online*, September 25, 2009.
[20] Myers, Ben. "Capturing the Canal: "Port of New Orleans, Gulf Coast look for share of Panama Canal Expansion traffic," *All Business* (a D&B Company), page 1.
[21] Myers, page 2.
[22] Mongelluzzo, Bill. "West Coast Ports Emphasize Competitive Edge," *Journal of Commerce Online*, March 31, 2010.

of Shipping has speculated that the tolls could rise so high that British shippers could be deterred from using the canal.[23]

Bruce Lambert, formerly of the marketing department of the Port of Long Beach and now the Executive Director of the Institute for Trade and Transportation Studies, notes that most East Coast ports are incapable of handing mega-ships due to draft limitations or in the case of New York and New Jersey, bridge clearances. Further, tolls necessary to retire the massive debt required to construct the new lock chamber will have to weighed against West Coast rail rates to make a decision as to which route to take[24].

Last, the post-Panimax vessels, due to their size, are very expensive to keep at port; thus their ports of call could be limited to 2 or 3, with one possibly being Houston and another being Cuba or an East Coast port. It is also possible that New Orleans could be a port of call for the post-Panimax vessels.

John Vickermann, general consultant to the Louisiana International Gulf Transfer Terminal (LIGTT) project, would like post-Panimax ships to call on the Port of New Orleans, transload to smaller vessels which would transport cargo in all directions. He calls this the “hub and spoke” distribution system[25]. This model is very different than land-based distribution systems that distribute cargo by truck or train. This distribution system requires a new terminal to be constructed in the Plaquemines Parish at a cost of about one billion dollars. Construction funds would necessarily come from private sources. Further, existing ports could handle the forecast tonnage, but their distribution system is land based[26].

In summary, whether or not southeastern states have an influx of container traffic due to a Panama Lock upgrade is arguable. One school of thought argues that shippers have no choice but to use an all-water routing because of projected congestion, fees, taxes and rail costs at the West Coast terminals. Others argue that congestion is not an issue and, further, that the tolls required to retire the debt required for new lock construction will make the all-water route non-competitive, especially if rail rates are set to protect their container traffic.

A reasonable conclusion is that some of the growth in container traffic will occur at Gulf terminals, either shipped in the Panimax or post-Panimax vessels. Whether this traffic is processed at existing terminals or at the proposed (and unfunded) LIGTT terminal, the problem of transit time remains an issue. The creation of a “spoke” delivery system with traffic shipped to Memphis from the LIGTT terminal would have the same problem that container-on-barge has now, i.e., a longer delivery time by barge versus truck and rail delivery.

[23] Blake, Heidi. “Panama Canal Widening Raises Fears About Tolls”. http:/www.telegraph.co.uk/journalists/heidi-blake/
[24] Mongelluzzo.
[25] Myers, page 1.
[26] Quillen, Kim. http://gulftranster.com/news

Missing from the literature on the Panama Canal upgrade is any estimate of the benefits of an all-water route as compared to a land routing from the western ports. A suggestion would be to make a variety of assumptions and calculate which routing would be the most advantageous.

High Value Goods

In their examination of the potential for shippers and carriers of high value commodities to consider using barge transportation as part of their supply chain management philosophy, CTR contacted the Kenco Corporation in Chattanooga, referenced Wal-Mart (through their interview with Greg Pritchet of the Henderson County River Port Authority), and interviewed a representative of the Bridgestone Metalpha Corporation in Clarksville, Tennessee. Wal-Mart is a shipper and carrier, Kenco is a third party logistics provider (3PL), and Bridgestone manufactures steel-belted radial tires. 3PL's are firms that provide one stop service to its customers of outsourced logistics services for part or all of their supply chain management functions. In the Global Insight database, Kenco is classed as providing warehousing and distribution services. Wal-Mart is ranked by Forbes magazine as the world's largest public corporation by revenue in 2010, and Kenco was ranked by *Inbound Logistics* as a top 100 third party logistics provider. Bridgestone is a leading manufacturer of tires for automobiles, light trucks, and SUVs.

CTR learned there is very little potential for high value goods to be distributed by barge transportation, barring some unforeseen circumstance. As noted above, Wal-Mart, upon receiving their containers, reconfigures their containers specific to demand and then trucks the containers to each prescribed location. Kenco receives, warehouses, and distributes containers on demand generally by truck transportation. Kenco used rail intermodal facilities until CSX pulled their ramps back to Atlanta. They have some potential for intermodal service on their inbound movements, but they see no potential to change their mode of operation as long as this nation relies heavily on the JIT transportation model.

Bridgestone, however, would prefer to ship their coiled steel directly to their manufacturing plant in Clarksville rather than trucking back to the plant from Nashville or trucking from Savannah. Clarksville does not have the terminal capacity to handle the tonnage they need to ship. If a general commodities terminal was constructed in Clarksville, Bridgestone could rent warehousing space for their steel coils. They do not need temperature or humidity controlled warehouses.

Liquids

Where the pipeline infrastructure is available, light petroleum is shipped via this mode as it is the least expensive of the transportation alternatives. Where the pipeline infrastructure is not available, shippers prefer to transport gasoline, jet fuel and kerosene by barge transportation if sufficient storage is available. Liquids are shipped into the Nashville area by pipeline, barge, and truck transportation. In Clarksville, there is no infrastructure to transload and store gasoline so this fuel, barged to Nashville, is shipped back to the area from Nashville where the storage tanks are available.

The TEPPCO Corporation has proposed to barge fuel into Clarksville such that the trucking operation now used to ship gasoline into the city would no longer be necessary. TEPPCO (now called Enterprise Products) has purchased 22 acres in the Clarksville area on the navigable stream to complement the distribution facility at Bolgie, Alabama. This distribution facility is located in the city where the Colonial Pipeline crossed the Tennessee Tombigbee Waterway. Enterprise Products desires to locate in Clarksville because Nashville is expanding out to Clarksville, and the company desires to avoid the congestion of Nashville. The company estimates that they will ship 15,000 barrels of petroleum per day into Clarksville. This equates to 747,338 tons or petroleum per year (15,000 x 365 x 42 gallons per barrel x 6.5 pounds per gallon). The facility is estimated take 70-80 trucks per day off of I24 as much of the petroleum moving into Nashville is furnished by truck transportation due to limitations of pipeline service into Nashville.

Due to the economies of unloading liquid asphalt, this commodity is generally always transported by barge transportation if possible. Like gasoline, asphalt is barged to Nashville where it is stored and then trucked back to Clarksville as needed at the batch plants. McIntosh trucking currently brings in about 250,000 tons of asphalt annually from Nashville.

Last, the Fort Campbell army base receives a considerable amount of fuel that is presently being trucked in from Indiana. Any potential shipments to the base are not included in the calculations given above. However, Enterprise Products could conceivably supply the fuel needs of the base from their proposed facility in Clarksville.

Coal

It is public knowledge that TVA is considering construction of a coal transloading terminal at the Kingston Steam plant on the upper Tennessee River in the Watts Bar pool. Currently, this plant does not receive any coal by barge transportation, but the possibility exists that coal could be shipped to the plant. Several locks would be transited to reach the plant, but the volume of the traffic would be limited by the effective capacity of the two 60 x 360 foot locks on the upper Tennessee River (Watts Bar and Chickamauga). Locks below Chickamauga are sized at least 110 x 600 feet and thus do not have the capacity restrictions of the smaller locks. CTR estimates that coal traffic barged to Kingston steam plant could approach 5 to 5.5 million tons annually.

The shift to barge transportation would be driven by the savings that would occur per ton of coal delivered. And, of course, TVA rate analysts are the ultimate arbiter of the shipper savings that the agency would incur given the shift from rail to barge transportation. Plans to go forward in construction of the coal terminal would be based on the benefit to cost ratio of the shipper savings weighed against the cost of construction. Of course, there are other factors to consider: Will Chickamauga Lock remain operational such that coal can reach the plant by barge? Also, there is the issue of how home owners in the area would react to such a dramatic shift in delivery.

CTR could not get an interview with TVA on this matter. However, this is the most likely case, simply based on the economics, where a large amount of coal, or any other commodity for that matter, could be shifted to barge transportation from either rail or truck transportation.

Dry Bulk Cargo

Dry bulk cargo includes such commodities such as coal (discussed above), steel, grain, sand, gravel, zinc ores and similar commodities. CTR finds two types of non-coal dry bulk commodities that have some potential to divert from truck to barge transportation: (1) those that can divert given construction of a general commodities terminal at Clarksville and (2) diversions that could occur if construction stone used in federal and state government projects was shipped by barge where appropriate.

A general purpose barge terminal in Clarksville could attract the following dry bulk commodities that are presently being trucked into the area: salt, petroleum coke, agricultural lime, cement, concrete blocks, tile sand, scrap metals, and unpolished limestone. Steel coils have already been discussed in the "high value" section of the paper. A major salt company is looking for a distribution center for road salt. Agricultural lime is presently being trucked into West Tennessee, with Ohio River sand being the back haul commodity[27].

There are five ready mix companies in Clarksville. The material is shipped by barge to Nashville and trucked back to Clarksville. The companies are Orgain, Nashville Ready Mix, IMI, 101st Ready Mix, and Hopkinsville. A general commodities terminal could provide storage for these companies such that cement could be distributed out of Clarksville.

Wynn Terminals was bought out by Vantacore, which is a limited partnership capitalized at $100 million. The business is a limestone quarry and focuses on aggregates. The quarry has 500 leased acres with 100 acres zoned industrial. Their expansion plans hinge on a request for rezoning which will come this fall. Queen City Metals now leases property from Winn and cannot expand their operations due to a lack of space. Wynn plans to expand their operation with a 600 foot seawall connecting to their present dock. If this happens, Queen City Metals can expand their operation. Wynn currently has only one loading dock, and Queen City Metals can only have intermittent use.

The modal choice for zinc ores depends on (1) the world price of zinc and (2) whether the manufacturer handles their own freight or contracts with a third party to ship the ore for them. The Global Insight 2007 truck file records Nyrstar Zinc as having at least a portion of their zinc ore shipped by truck from the Port of Savannah. Nyrstar's preference is to ship through the Port of New Orleans, but Savannah was the preference of their steamship carrier in 2007. During this period, Nyrstar's spokesman said that the Port of Mobile (the TTWW route) was too expensive. The tonnage per tow was too low because of the possible maximum tow size and there are too many locks on the waterway. Thus, the port of call is a significant factor in how the product is shipped to final demand. The Alcoa Aluminum Company in Blount County, Tennessee also appeared in 2007 to receive its ores from Savannah.

When the world price of zinc rose, it became profitable for Nyrstar to begin producing zinc ores domestically, thus they have reopened their mines in the Jefferson City/Strawberry Plains area of

[27] For this movement to occur, a terminal on the Tennessee River is necessary. The permitting process for this to become a reality is eminent or at this point is on-going.

East Tennessee and are employing 1,000-1,500 people, producing agricultural lime, zinc ore, and gravel. They are loading on to barge transportation at Burkhart Terminal above Knoxville and shipping two barges per week. Their actual tonnage is 105,000 metric tons per year (wet) which when dried equates to 96,000 metric tons. Volunteer Barge is the barge carrier.

A tile manufacturing operation barges in some of their input quartz sand to Wynn's terminal and trucks in the remainder from Arkansas. They bring in black aggregate rock which they crush and use as input into their tile manufacturing process. They can only make limited use of Wynn's site because they do not enough space to load and unload barges at the same time. They bring in 2 barges a month from Arkansas around Little Rock. It is normal for them to bring in 6 trucks per day from Arkansas loaded to 22 tons. They must use truck transportation due to the undependability of barge transportation. They must have this rock on hand to continue production, and Wynn does not have adequate space for a lay down area.

As noted previously, broken stone commodities are the only group in Tennessee where the predominant shipment pattern is local, inbound, or outbound from the state. However, as shown above there are long truck shipments that could have incorporated as least one leg of the shipment by barge. A spokesman for the Vulcan Corporation noted that the destinations for stone products in Tennessee are generally on navigable rivers. The per capita consumption of stone products is higher in urban than in rural areas: 10-15k (urban) and 5-10k (rural). Stone products trucked long distances are thought to include non-polishing (nonskid) stone used in paving mixes. This material sells for $20/ton. Other high value stone products trucked long distances are 300 mesh products (very fine powder generated in broken stone manufacturing) used in plastics and paint manufacture. This material can sell for $30 to $100 per ton.

Impediments to Modal Shifting

The impediments to a modal shift from overland to barge transportation are numerous. In the Clarksville area, the impediments are not well understood. First, there seems to be more parties vying to serve a market that is too small to provide each with adequate revenue to sustain their operations. There are at least three parties that would like to construct a general purpose terminal in the Clarksville area: Wynn Terminal, the Cumberland River Regional Waterway Intermodal Facility, and the River Chase Marine Terminal (RCMT). The Vulcan Corporation applied for a Section 404 permit on the Red River in 2002 but subsequently withdrew the application. RCMT is already permitted from the U.S. Army Corps of Engineers (USACE) and site plans have been made for a multipurpose port with 100 acres zoned for industrial development. Enterprise Products, which purchased 22 acres of the site, was to have applied for their River and Harbors Act Section 404 permit and their Section 401 Clean Water Act permits, but the USACE reports that they have not as yet applied for their Section 404 permit.

The Wynn Terminal is now owned by Vantacore which is a limited partnership capitalized at $100 million. The quarry has 500 leased acres with 100 acres zoned industrial. Their expansion plans hinge on a request for rezoning which will come later this fall. The Wynn terminal now plans for an expansion on the Tennessee River. Both terminals will require Section 404 permits, and the Tennessee River terminal will require a TVA Section 26(a) permit. In the short term, Wynn needs more dock space and lay down area.

The site proposed for the RCMT terminal is on land currently controlled by Nyrstar NV. The land includes 1,600 acres that is largely suitable for further transportation-dependent commercial developments. The site is also served by the RJ Corman's Memphis line which interchanges rail traffic with CSXT at both Guthrie and Bowling Green, Kentucky.

Second, and more generally, many potential users do not know that barge transportation is an option for them. Mr. Tim Jones at Burkhart Enterprises noted that potential clients had no idea about the wide range of commodities that could be shipped by barge transportation. Shippers understand trucking; they don't understand barging. Also, shippers are very sensitive to delays, especially unanticipated delays. With a move to barge transit and one long, unanticipated delay, and the shipper is back with truck or rail carriage.

Third, truck transportation is much easier to use than barge transportation, with very little lead time and a minimum need for storage. Additionally, shippers may believe they can arrange to have their freight moved at rates that are either less expensive than or roughly equivalent to the barge rate[28].

Fourth, state and federal government through their contractors require substantial shipping of stone products. These agencies have not made a conscientious effort to use barge transportation.

Fifth, if barge transportation could be an option for shipment of stone products, docks for the unloading of the product are sometimes not available. There are environmental objections for the docking of barges along the sensitive shoreline areas where plant and animal wildlife are found. Mussel beds are frequently found in the shallow areas along the shore lines.

Sixth, the equipment needed to ship stone products by barge is sometimes in short supply. A rise in the price of steel in 2007 resulted in the scrapping of deck barges needed to ship riprap. The modern deck barges needed to ship this commodity are not now available on the Tennessee and Cumberland Rivers.

Seventh, barge rates were out of line with truck rates in 2007 (see footnote 28). This was a factor in certain movements not being shipped by barge.

Eighth, an open hopper barge can carry 1,600 tons of cargo which is equivalent to about 70 tractor semi-trailers. Generally, most shippers do not need to ship quantities of this magnitude. This is one major reason why truck transportation is so attractive.

[28] CTR finds shippers have long institutional memories. When asked about movements referenced in the 2007 Global Insight data base, they complained about high barge rates. Rates, however, have fallen substantially since then, and their observations about truck versus barge rates may not reflect current conditions.

Benefits of Modal Shifting

The primary potential benefit to the shipper of using barge transit is lower shipping costs. In the truck diversion simulation exercise discussed below, we examine the impacts on I24 of a diversion from truck to barge transportation based on one of the movements referenced in the Global Insight file. This movement is 266,511 tons moving from the quarries in Montgomery County to I40 in Wilson County. We do not know the exact commodity or the exact destination, so we are assuming the commodity is non-polishing stone moving to a portable batch plant. A likely destination would have been the Garrott Brothers, Inc. Gallatin Dock. This terminal, located at mile 240.2, right bank of the Cumberland River, receives dry bulk commodities including sand, gravel, salt and stone products. The dock has an open storage area with a capacity of 150,000 tons of stone. It is further assumed that the portable batch plant is located at or near the dock. As shown below, the barge rate per ton is estimated to be about half of the truck rate. This calculation assumes that the stone trucks would be travelling at an average speed of 50 mph, and this might not be reasonable at certain times of the day given traffic congestion in Nashville. Thus, the savings might be greater than expected.

The time required for truck delivery is assumed to be 4.0 hours. This calculation is shown in Table 19. The cost per hour of operating a commercial heavy truck over the road is estimated to be $75 per hour. Thus the cost per trip is $300 ($75 x 4.0). Assuming that the trucks were loaded to 26 tons, the cost per ton of truck delivery is $11.54 per ton. Using the Barge Costing Model developed at TVA and in current use by the USACE, the general barge towing rate would have been $3.76 for delivery of the stone product to the dock. This calculation assumes a fuel cost of $2.40 per gallon. The final per ton trucking rate would include $1.25 to load and $0.75 to unload, resulting in a total rate of $13.54 per ton. The final barge rate would include the line haul rate plus a $1.00 per ton loading charge and a $1.75 unloading cost, resulting in a total per ton barge rate of $6.51 per ton. Thus, the barge rate for this movement would have been a little less than half of the truck rate. In a dedicated tow, the line haul cost would have been a little less expensive-$3.58 per ton. But due to a lack of competition and scarcity of equipment, the towing rate would be expected to be somewhat higher at possibly $4.00-$4.50 per ton.

Table 19: Time Required for Truck Delivery

Operations	Hours
Load cargo	0.5
Loaded trip	1.5
Unload cargo	0.5
Empty return trip	1.5
Total	4.0

The shipper savings due to this one movement is estimated to be $7.03 ($13.54-$6.51) per ton, resulting a total savings to the shipper of $1.9 million.

Encouraging Diversion to Barge

Federal and State Government Options

Federal and state governments do have some flexibility and leverage in moving highway traffic to the waterways in Tennessee. These agencies could first investigate planned construction projects to determine if water transportation is an option in the movement of stone or other products to construction sites. Second, they could make modal preference integral to the contract-making process. That is, if water transportation could possibly be used in the execution of a contract, then it could be required. Third, TDOT could develop an advertising program to alert Tennessee shippers as to the potential benefits of shipping by water. Fourth, both agencies could investigate a multi-state corridor study to determine the benefits of using the navigable waterways as a transportation corridor. In examining the Global Insight data base, long-distance stone movements passing in, out, or through multiple states can only be understood or addressed when the state and federal governments have open communication lines. Long-distance truck hauls from Tennessee into Mississippi are most likely destined for MDOT construction projects, and it would have to be MDOT that addressed the transportation issue, as TDOT would have no information about the movement. A multi-state consortium could lower the cost of operating all of the DOTs, make better use of the waterway infrastructure, improve air quality, lessen congestion, and make our highways safer.

Advertising

Tim Jones at Burkhart Enterprises suggested that state government could develop an advertising campaign to promote barging in Tennessee. It has been Tim's experience that in their marketing activities potential clients do not know that barging is an option for them. Barging is a quiet industry and not well understood by most people.

Partnerships with the Shippers and Carriers

The state could gain if TDOT entered into a working relation with shippers[29] of broken stone commodities, which are often times their contractors. For large shipments from particular origins to particular destinations, portable docks could be moved around the inland river system to facilitate the unloading of stone products to truck for delivery to final destinations[30]. If an arrangement could be worked out such that water delivery, where possible, could be the first option for stone products transportation, then sufficient traffic might be generated to allow private industry to finance needed barges and operation expenses. Portable docks and spud barges are needed to offload waterborne stone shipments, and deck barges are needed to haul stone material that is over six inches in diameter. Second, the states could become partners with the barge carriers. If the states would examine their data and provide a forecast to the carriers, private industry could provide the

[29] Shippers are defined as those who "pay the bills". Carriers are those who haul the material.
[30] As discussed in the data section above, the USACE shipped a large quantity of riprap to stabilize levee banks damaged by hurricane Katrina. One reason given for not using barges to haul the stone material was that docks were not available. Spud barges, had they been available, could have facilitated the unloading of the deck barges, also, had they been available.

equipment to haul the commodities by barge. The deck barges needed for transportation of large sized stone materials are not in wide usage—neither AEP nor Ingram Barge Company presently has them. Also, floating docks have been shown to be a good idea. They are being used now on the Ohio and Tennessee Rivers as a means to unload stone products while doing minimum disruption to the shoreline. In the interview with Burkhart Enterprises, Mr. Jones said that two companies were now doing riprap operations on residential lake properties in the Fort Loudon Reservoir, using a floating dock with spud barges. Burkhart is trucking the stone product to their dock for loading onto the deck barges.

Backhauls

As noted above, barge transportation would have been very competitive with truck delivery for the stone product movement from Montgomery County to Wilson County. Also, in the long movements of stone to Mississippi from Montgomery County, barge transportation would also be very competitive if a backhaul could be arranged. One possibility would be mulch for lawn improvement or biomass fuel.

Examine Historical Data

It became apparent as CTR began to use the Global Insight data base, that too little information is available to make specific comparisons between overland and water transportation rates. While we have gleaned enough information from the Global Insight data to determine that construction materials are the most likely candidate for diversion to waterway transit, CTR suggests that the best way to make modal cost comparisons is to examine historical TDOT contract data. With specific origin, destination and commodity data, the transportation rate analyst can determine if the state may have lost or gained when their contractors used trucks to haul construction materials versus barge carriage. Based on the analysis of historical data, TDOT managers can determine whether it is useful to examine new contracts to determine the gain or loss of requiring the use of barge transportation where appropriate.

Freight rates are dynamic in that they respond to supply and demand considerations. In the interview process, CTR was told that long-distance stone movements were captive to truck transportation because Cumberland River barge rates were too high, the waterway routing was too circuitous, and navigation on the Tennessee Tombigbee was too inefficient. During the period 2007, the year of reference for the Global Insight database, barge rates were very high—AEP's retail towing rates was $30/ton. They are now at $12/ton and thus much more competitive for barge transportation.[31]

Assuming that the cost comparison demonstrates that water transportation is not too costly, TDOT could examine its options, with one possibly being a modal preference in their contract-making process. Each contract could be examined to determine if barging is feasible for the transportation of stone products and, if so, use of barge transportation could be required in contract proposals. In urban areas, this could substantially reduce highway congestion.

[31] This information was obtained in an interview with an AEP senior manager.

Alternatively, if the barge rate is higher than the truck rate, TDOT could consider a subsidy. By calculating the diversion's positive impact on the environment and comparing this benefit to the net higher cost, CMAQ funds might be used to fund the subsidy. It is quite likely that the gain in environmental benefits would outweigh the increase in cost.

The economic and environmental impacts of two highway diversions to barge transportation are discussed below. One case study involves the assumed construction of a general commodities terminal in Clarksville. In the other, a broken stone truck movement out of Clarksville is assumed to shift to barge transportation.

A Truck-to-Barge Diversion Impact Simulation Exercise

Overview

The highway traffic model used in this report to estimate impacts from two potential truck diversions is a Microsoft Excel/VBA application that tracks hourly traffic volumes on specified highway links for up to 51 years. In each case the model simulates future traffic flows for a base case and for the alternative to derive the impacts for the impact scenario.

The two impact scenarios are:

Scenario1: A diversion to barge of I24 truck traffic carrying various commodities from Nashville to the Clarksville area

Scenario 2: A diversion of broken stone truck traffic to barge from downtown Clarksville along I24 to Nashville.

To evaluate the scenarios, the distinct characteristics of each stretch of roadway in the highway network (twenty-one links in all) from Clarksville—either downtown or an I24 exit-- to the Nashville exit on I24 leading to the river terminals are input into the model. For each link, resident highway traffic counts and roadway characteristics are sourced from the Tennessee Department of Transportation's TRIMS data base. TRIMS data only include traffic counts for state and federal roadways; thus local roads are excluded from the simulations.

Scenario 1 is based on field and telephone interviews identifying certain traffic flows that could be diverted to barge were appropriate barge terminal facilities developed in the Clarksville area. Presently, this infrastructure is not available in Clarksville, and thus barge tows move past the city and terminate in Nashville where the facilities are available. Truck transportation is then required to move the transported goods back to service the market in the greater Clarksville area. The terminal facilities required in Clarksville include the infrastructure needed to transfer and store light petroleum and asphalt, adequate docking space and warehousing for dry bulk cargo, and lay-down areas for materials not needing to be covered.

The second scenario model is one example of the previously discussed broken stone products that are hauled significant distances by truck. The traffic diversion model is used to evaluate the impacts of removing shipment totaling 266,511 annual tons that, in the Global Insight file, are reportedly moving between Montgomery County and Wilson County. Although the database does not provide the actual source of the movement in Montgomery County, it began its journey on State Route 13 and ended on I40.

The Traffic Impact Model

The model accepts a variety of user inputs for a specific traffic scenario. These include the changes to truck traffic entailed in the impact scenario, base case traffic growth rates, and the number of forecast years, plus constant dollar fuel price per gallon, value of travel time for auto and for truck, accident cost factors for auto and for truck, and emission cost factors for five pollutants. For a route, inputs include characteristics for each highway link in the route, such as terrain, number of lanes, speed limit, and base year average daily traffic (ADT) as a total and for trucks.

Several tables are embedded as inputs to the model's algorithms: highway capacity factors by road characteristics, hourly traffic percentages by functional class and direction, and grams of pollutants per mile (truck and auto by 5mph speed bin and year).

For a 50-year run, the model outputs some 75,000+ values in tables in various worksheets. For the base case and an alternative scenario, the tables include:

- vehicle miles traveled (VMT) for auto and truck, by year and 5mph speed bin, travel hours, VMT, fuel costs, pollutant costs for auto and truck, by link, average speed by hour and direction by (user selected) link and year
- minimum speed occurring during year by link and year
- kilogram emissions by year

The model calculates hourly traffic flows, based on specified distribution patterns, for each combination of base and diversion scenario (day and night), vehicle type (automobile or truck), and direction. Diverted trucks, where a truck-to-barge diversion scenario is being simulated, are removed from base traffic volumes, and the percent trucks for the hour and direction changes accordingly. The calculated truck percent enters into the capacity calculation routine affecting average speed. Along with the segment length, the average speed determines travel hours and fuel consumption per mile for autos and for trucks. Total vehicle miles traveled are determined by segment length and traffic volume.

Vehicle miles traveled by 5 mph ranges, by year for auto and for truck, are calculated in a subroutine that performs the necessary volume growth calculations, accumulates the quantities into the required average speed bins, and writes the output in a worksheet.

Highway Traffic Equations[32]

For each scenario, the model distributes ADT by hour and direction for each highway link based on the functional class of the link. Each link's traffic capacity is calculated based on road type, terrain,

[32] This information is taken from *Social Costs of Barge Cargo Modal Diversions Due To Unscheduled Closures at Emsworth, Daschields, and Montgomery Lock.*

and the percentage trucks are of total traffic. Capacity decreases as the percentage of trucks rises and speed decreases (and travel time increases) as the volume/ capacity ratio rises.

Capacity in one direction for one lane is given by:

Urban freeway, non-signalized, Sf = 55 mph

c=2300*PHF*Fp/(1+Pt(Et-1))

Assume PHF=0.9, and Fp=1.0

Rural freeway, non-signalized, Sf = 65 mph

c=2400*PHF*Fp/(1+Pt(Et-1))

Assume PHF = 0.80, Fp = 1.0

Non-freeway 2-lanes or 1-lane, non-signalized; Sf = 55 mph

c=1700*PHF*Fp*Fg/(1+Pt(Et-1))

Assume PHF = 0.85, Fp = 1.0

Signalized urban arterials, signal spacing <= 2 miles

c = 1900*PHF*(g/c)/(1+1.0*Pt)

Assume PHF = 0.90, g/c = 0.45

where PHF = peak hour factor (distribution of traffic in the peak hour)

Fp = adjustment for driver familiarity

Pt = proportion of heavy vehicles

Et = passenger car equivalents (varies by highway type and terrain)

Fg = grade adjustment factor

g/c = duration of green to cycle length

The NCHRP report 387 provides the following speed and travel time equations:

Travel times for each link are determined as follows:

- For roads without signals
  - Posted speed limit > 50 mph

Sf = 0.88 * Sp + 14

S = Sf/ (1+0.15 * (v/c)^4)[33]

T = 1/S. This is travel time.

[33] This speed equation has its origin in the Bureau of Public Roads. It is used for adjusting speeds for traffic assignment on a road network for the planning of roadways.

- Posted speed limit <= 50 mph

  $Sf = 0.79 * Sp + 12$

  $S = Sf/(1 + 0.05(v/c)^{10})$

- For roads with signals

  $Smb = 0.79 * Sp + 12$

  $D = Df * 0.5 * C * (1-.45)^2$

  $Sf = L/(L/Smb + N' * (D/3600))$

  $S = Sf/(1+0.05 * (v/c)^{10})$

  $T = 1/S$

where

Sp = posted speed limit in miles per hour (mph),

Sf = free flowing speed in mph,

S = average speed in mph,

V = traffic volume by direction by hour,

C = capacity in one direction in vehicles per hour,

T = travel time,

Smb = the mid-block free flowing speed in miles per hour,

Df = degree of coordination between signals (NHCRP Report 387 suggests that Df should equal one when fixed time signals are uncoordinated,

C = cycle length = 120 seconds,

D = delay in seconds per vehicle,

L = length of segment;

N = the # of signalized intersections in each link.

Social Cost and Impact Computations

Once the model finishes calculating automobile and truck flows, it proceeds to estimate social costs for the base case and the diversion scenario. Outputs for the simulations performed in this exercise include tables of annual values for autos and trucks of travel hours, vehicle miles travelled, accident costs, and pollution costs. Hours and miles are converted to costs for congestion and fuel. The dollar differences in these cost factors between the impact scenario and the base case are the annual impacts, from which a present value is calculated.

The next section discusses the components of social costs in more detail.

Congestion Delay

Non-Commercial

Travel time is an important component of highway user costs. The potential to decrease travel time resulting from diversion of Tennessee highway truck traffic to the river could result in significant impact on those costs. Economists have studied the value of time and in particular how motorists value their time in traffic delays[34]. The value of time for the motorists depends on the opportunity cost of using their time in some other manner. Revealed preference studies, that is, studies of the value of time based on actual choices, allow values to depend on wage rates, incomes, and other factors[35]. Small and Winston, in a 2005 study, examined the behavior of motorists in Los Angeles who may use express lanes but must first set up a financial account and carry an electronic transponder in order to pay a toll. The authors find that the average valuation in the value of time is quite high, thus suggesting that time is much more valuable than the revealed preference theoretical model might suggest.

The U.S. Army Corps of Engineers has also studied the value of time. David Hill and David Moser laid out guidance for handling this problem in 1991 in the Institute for Water Resources Report, *Value of Time Saved for Use in Corps Planning Studies: A Review of the Literature and Recommendations*. The report focuses on the value of time related to personal vehicle use but gives no guidance on value of time to commercial operators. The report cites a rich array of studies on the subject including the American Association of State Highway Officials (AASHO). Since the Corps report was published, AASHO (now AASHTO, the American Association of State Highway and Transportation Officials) has published further guidance to highway planners. The latest AASHTO report is commonly referred to as the Red Book[36].

The Red Book document suggests that the value of time for personal vehicle use is 50% of the wage rate per person in each vehicle. The CTR follows the suggestion in the Red Book and uses the 50% factor, which seems conservative in view of the findings of Small and Winston. In 2005 the average wage rate per employee per year in Allegheny County was $36 thousand or $17 per hour. The value of time for non-truck traffic is thus $8.50 per hour per person.

The Bureau of Transportation Statistics (BTS) reports that, for all personal vehicle trips in the nation, there are 1.63 persons per vehicle[37]. Vehicle occupancy by type of trip is shown in Table 9. Note that occupancy in work related trips is 1.14 which is the lowest value among the different types of trips. Deitrick and Briem reproduce Census data for Allegheny County and the 6 county remainder of the

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[34] For example, Calfee, J. and C. Winston (1998). “The Value of Automobile Travel Time: Implications for Congestion Policy,” Journal of Public Economics, 69, pp. 699-707.

[35] Small, K.A. and C. Winston (1999), “The Demand for Transportation: Models and Applications,” in Gomez-Ibanez, W. Tye and C. Winston editors, Essays in Transportation Economics and Policy: A Handbook In Honor of John R. Meyer, Washington, DC: Brookings Institution Press.

[36] American Association of State Highway and Transportation Officials (AASHTO), User Benefit Analysis for Highways Manual, August 2003.

[37] Bureau of Transportation Statistics, daily trip file for 2001.

Pittsburgh MSA[38]. The data show that in Allegheny County 72.1% of the commuters drive alone. In the remainder of the MSA, 83.8% drive alone. These data provide some evidence that, at least for commuters to work, it is appropriate to use the national data to reflect local conditions.

Table 20: National Vehicle Occupancy per Vehicle Mile by Daily Trip Purpose

Trip Purpose	Mean Value
All Person Vehicle Trips	1.63
Work	1.14
Work-related	1.22
Family-Personal	1.81
Church-school	1.76
Social-recreational	2.05
Other	2.02

Using BTS's mean value for all trips, the total estimated cost per hour is $13.86 ($8.50 x 1.63).

The CTR methodology is comfortably compatible with the aforementioned Hill and Moser document. For high time savings over 15 minutes, Hill and Moser suggest $8.33 dollars (1991 dollars) on a per vehicle-occupant basis. For other trips they suggest $9.98 on a per vehicle basis. For reference, the CPI calculator suggests an inflation adjustment from 1991 to 2005 of 1.43. Adjusting work trips for inflation and using the work-related vehicle occupancy rate suggested in the table above, the Hill and Moser work related savings would be ($8.33 x 1.43 x 1.14 = $13.58). The current value of the other trips category is $14.27 ($9.98 x 1.43). One other category suggested by Hill and Moser is social and recreational trips. The current value of time savings for this category is $13.28 ($9.29 x 1.43). Thus, whether suggested parameters come from the Red Book or from inflation adjusted data offered by Hill and Moser, an estimate of cost per hour per vehicle is approximately $14.00.

Commercial Highway Use

The opportunity cost of a commercial truck is equal to the benefit-loaded cost of hiring a new driver plus other operating expenses. The TVA has surveyed commercial highway users and found that the average cost of supplying a semi-tractor trailer driver is $65 per hour including fuel. But since this study groups all commercial vehicles together, the rate of $55 per hour might be more reasonable since some of the deliveries would be made in smaller commercial vehicles that are less expensive to operate than the larger trucks[39]. However, the cost of fuel must be netted out. TVA estimate that, of

[38] Allegheny County Economic Trends, page 57.
[39] The commercial data were supplied by TVA in an email dated March 4, 2008.

the $55 per hour estimate, $13.10 should be allocated to fuel consumption, leaving $41.90 as the net time value cost per hour.

Fuel Consumption

The model calculates fuel saved by the subtraction of existing trucks from the traffic flow. When these trucks shift modes, delays and driving times are reduced for the remaining traffic. These remaining vehicles, trucks and automobiles, consume less fuel per trip. The reduction in fuel consumption by the trucks left remaining on the highway is an externality. The CTR estimates the required fuel consumption for all vehicles in the base case and in the two scenarios, nets out the decrease in fuel consumption, and values the cost of the net increase at a real cost of $3.00 per gallon[40].

Crash Costs

Less truck traffic on the roads can enhance highway safety, decreasing either or both the rate and severity of accidents. Calculating accident costs can be very complicated, as accident frequency and accident unit costs must be computed. Total accident unit costs include all costs resulting from fatalities, injuries, and property damage. As discussed in the Red Book, "…accident unit costs are calculated net of insurance costs to avoid double counting that portion of costs that are already covered by insurance."[41] Insurance costs are a cost of doing business and are included in calculations of transportation rates.

The U.S. Department of Transportation provides accident cost data by category of accident for fatal accidents, non-fatal accidents, and property damage and for all accidents[42]. Table 10 presents these data for the year 2000; the values are converted to the initial year values in the EXCEL workbook for use in estimating the accident costs due to the diversions to truck:

Table 21: Motor Vehicle Accident Costs in Cents per Vehicle Mile Traveled (2000 dollars)

Category of Accidents	Passenger Cars	Large Trucks
Fatal Accidents	4.2	5.86
Injury (non-fatal Accidents)	11.16	3.66
Property Damage Only	0.61	0.38
All Accidents	15.97	9.90

In 2000 dollars, the CTR used 15.97 cents per VMT for the accident costs for personal vehicle travel and 9.9 cents per VMT for commercial trucks.

[40] It is possible that a small amount of double counting will occur as fuel costs for the diverted traffic also appears in the shipper savings calculations. However, this potential effect is felt to be too small to be of any consequence.
[41] Red Book, page 5-23.
[42] U.S. Department of Transportation, National Highway Traffic Safety Administration, *Traffic Safety Facts 200*0. U. S. Department of Transportation, Federal Highway Administration, *Highway Statistics 2000.*

Air Quality

Vehicle Emissions

The model calculates air pollution emissions from on-road mobile sources by multiplying VMT (vehicle miles of travel) for the various scenarios times an emission factor (in grams per vehicle mile). It computes VMT for two vehicle types: heavy-duty diesel vehicles class 8b (HDDV8b) and all other vehicles combined. HDDV8b vehicles are those with GVWR (gross vehicle weight ratings) of more than 65,000 pounds equivalent to 18-wheeled tractor-trailer trucks. All other vehicles combined includes light-duty gasoline fueled automobiles, SUV's, pickup and delivery trucks, and light to moderate weight diesel vehicles (both cars and trucks).

Emission factors were obtained for each calendar year using the USEPA MOBILE6.2 emissions model, which determines emission factors for each pollutant, taking into account the model year, the national average age mix of each vehicle type, the average speed, fuel composition factors, and environmental conditions, such as ambient temperature and humidity. Emission factors calculated for this project are based on a minimum/maximum temperature of 56/80 F (average summer), the default humidity of 75 grains per pound of dry air, a gasoline RVP (Reid vapor pressure) of 7.8 psi and a diesel sulfur content of 43 ppm until May 2010, and 11 ppm after June 2010 as required by USEPA nationwide. The most important factors are vehicle type, age, and speed. Newer vehicles of all types generally have lower emissions than older vehicles due to USEPA's ever more stringent emission standards for newer vehicles. The MOBILE6.2 model predicts that emission factors for all pollutants will decrease in future years (as they have been since the first emission standards in the 1970's) until about 2030 when all existing emission standards will be fully implemented. In fact, emissions from mobile sources will probably decrease even after 2030, but future emission standards are not currently known, so the model cannot account for these reductions.

HDDV8b vehicles have the highest emission factors for particulate matter (PM) and nitrogen oxide (NOx) emissions compared to other vehicles. Nitrogen oxide emissions from HDDV8b vehicles vary by vehicle speed. For this reason, emission factors were calculated for a range of speeds from 2.5 to 65 mph for different calendar years from 2006 to 2051 and for HDDV8b vehicles only and all other vehicles combined. The mix of all other vehicles combined followed USEPA's default national average values built into the MOBILE6.2 model. The effects of vehicle age, model year, and speed on emissions are all accounted for in the MOBILE6.2 model, so emission rates from on-road mobile sources can be estimated throughout the United States on a consistent basis. The use of the MOBILE6.2 model is recommended by USEPA for calculating emissions from on-road mobile sources for transportation and air quality planning in all US states except California (California uses the CARB EMFAC model, very similar to MOBILE6.2).

For this study, the MOBILE6.2 model was used to calculate emission factors for particulate matter, nitrogen oxides, sulfur dioxide, VOC's (volatile organic compounds), and ammonia. Separate tables of results were prepared for each calendar year. In each table, emission factors for each pollutant, for

HDDV8b and all other vehicles combined, were summarized for each speed ranging from 2.5 mph to 65 mph in 5 mph increments. After multiplying emission factors times the VMT for each diversion scenario, total tons/year or pounds/day of emissions were determined for each scenario.

Air Quality Benefits

Whenever USEPA proposes stricter emission standards for pollution sources they conduct a cost/benefit analysis to estimate the costs and benefits of the proposed regulations. The costs are primarily the costs of installing more efficient pollution controls while the benefits are largely health benefits resulting from reduced air pollution concentrations. USEPA has performed many health effects and epidemiological studies that quantify the health benefits of reducing air pollution.

In 2000 USEPA implemented new emission standards for trucks and buses (as well as sulfur limits in diesel fuel) that are expected to reduce emissions by 97 percent from these vehicles. EPA further concluded that diesel exhaust is likely to cause lung cancer in humans and that the new standards would prevent 8,300 premature deaths annually. The new standards are expected to prevent 5,500 cases of chronic bronchitis, 17,600 cases of acute bronchitis in children, 360,000 asthma attacks, and more than 386,000 cases of respiratory symptoms in asthmatic children annually (See EPA Fact Sheet at www.epa.gov/otaq/diesel.htm). The new emissions standards are expected to reduce nitrogen oxide emissions by 2.6 million tons per year and particulate matter emissions by 110,000 tons per year, once fully implemented. In order to estimate the costs and benefits of saving lives, EPA uses $6 million per life saved (8,300 lives per year), resulting in a potential $49.8 billion benefit per year. According to EPA "the benefits of the action outweigh costs by 16 to one".

The methods EPA uses to relate the health effects to the change in ambient air pollution concentrations is beyond the scope of this report, but is based on epidemiological studies of the frequency of health effects in various cities with different air pollution concentrations. EPA developed a model called "BenMAP" (Environmental Benefits Mapping and Analysis Program) to estimate the benefits (dollars per ton of air pollution reduction) expected to result from the implementation of new the emission standards. This model was used by EPA in the RIA (Rule Impact Assessment) for the new truck and bus emission standards to provide "monetized benefit estimates of air quality improvements". BenMAP was run for different areas of the US to determine representative changes in air quality resulting from potential reductions in air pollutants, as well as the health and cost benefit resulting from the emission reductions. The values obtained for a 25% reduction in mobile source emissions (the minimum considered) were $ 372,797 per ton of directly emitted particulate matter, $59,780 per ton of ammonia, $8,961 per ton of nitrogen oxides, $27,088 per ton of sulfur dioxide, and $695 per ton of VOC's. The benefits attributed to ammonia, nitrogen oxides, sulfur dioxide and VOC emission reductions were due to their being precursors to particulate matter formed in the atmosphere after it is emitted, such that reducing these emissions also reduces particulate matter concentrations to which people are exposed. Note that while the cost benefit of reducing a ton of directly emitted particulate matter is much higher than for the other pollutants, nitrogen oxide emission reductions from trucks and buses are much greater than direct PM reductions, making the cost benefit of nitrogen oxide emission reductions comparable to the cost benefit from direct exhaust PM reductions.

For this study, the costs used to estimate each ton of emission reduction from mobile sources are the same values used by USEPA for the cost/benefit analysis in the RIA for the new emission standards for trucks and buses, based on the USEPA BenMAP model results. For each ton/year of emission change predicted by the traffic model, total incremental costs were calculated by multiplying the tons of emission reduction per year times the following cost per annual ton (as determined by USEPA for mobile sources):

- $ 372,797 per ton of directly emitted particulate matter
- $ 59,780 per ton of ammonia
- $ 8,961 per ton of nitrogen oxides
- $ 27,088 per ton of sulfur dioxide, and
- $ 695 per ton of VOC's.

Scenario 1 Results

Through the interview process CTR found that approximately 1.6 million annual tons of various cargos could divert from truck to barge transportation if the needed terminal facilities were developed in Clarksville. A distribution of the potential commodities, the average truck loadings, the days of the week of service, and the diverted trucks per hour including backhauls is shown in Table 22. In the simulation exercise, the Clarksville dry bulk terminals are assumed to operate in the daylight hours, while the liquid terminals operate 24 hours per day. The daily average number of trucks is estimated to be 28.1. Only I24 highway segments are modeled (being composed of 16 links).

Table 22: Potential Nashville to Clarksville Truck to Barge Diversions
(Dry Bulk Terminals Operating During Daylight Hours)

Commodity	Tons	Truck Loadings	Trucks	Days per Week	Daytime Trucks per Hour with Backhaul
Cement	60,000	22.5	2,667	6	1.4
Liquid Asphalt	250,000	23.5	10,638	6	5.7
Nonmetallic Minerals		23.5	6,383	6	3.4
Stone-nonskid	150,000				
Sand (backhaul)	150,000				
Scrap Metal	86,000	24.0	3,583	6	1.9
Gasoline	747,338	26.0	28,744	7	13.2

Commodity	Tons	Truck Loadings	Trucks	Days per Week	Daytime Trucks per Hour with Backhaul
Specialty Sand	41,000	23.5	1,745	6	0.9
Steel	67,210	23.5	2,860	5	1.5
Total	1,551,548				28.1

The present value impact of removing (initially) 28 vehicles per hour from the section of I24 between Clarksville and Nashville depends heavily on the discount rate and how fast the traffic base will grow over the next 50 years. When calculating present values in water and land-related projects, the USACE is required to use the discount rate that is established annually for this purpose. The appropriate discount rate for evaluating these projects is defined by the Water Resources Development Act (WRDA 1974 Section 80(a)). This rate in 2010 is 4.4 percent and is the rate used in this analysis[43].

At a compound growth rate in total traffic of one percent, shifting 28 trucks off of I24 per hour creates a present value of a $148.7 million dollar savings in social costs measured over 50 years. This is shown in Table 23. The predominant benefits are reduced congestion and fuel consumption. But there are also reduced crashes and less air pollution costs. And since highway capacity models produce nonlinear results, **a forecast rate of two percent in highway growth yields a social cost savings of $344.0 million. At a rate of three percent, the social cost savings is $1.218 billion.** All three growth rates register reduced congestion and fuel use as the principal beneficiaries of the reduction in truck traffic. Given that TDOT has estimated that a two percent traffic growth rate[44] is most like to occur on state highways for all types of vehicles, simulation results for that growth rate should be given the most weight when examining the results for policy decision making.

Table 23: Impact of Truck to Barge Diversions on I24 between Nashville and Clarksville

Social Discount Rate = 4.4%
28 Weekday Trucks/Hour, 365 Days/Year

Traffic Growth Rate	Cost Factor	50-Yr PV, M of 2008$
1%	Delay	-$83.8
	Accident	-$9.1
	Fuel	-$46.9
	Pollution	-$8.9
	Total Impact	-$148.7

[43] The various rates are published on the U.S. Department of Agriculture, natural Resources Conservation Service's Web page: www.economics.ncrs.usda.gov/cost/priceindexes/rates.html

[44] Mr. Tony Armstrong, TDOT Planning Division, notes that the two percent growth rate is estimated by the ADAM computer database program. An email was received to this effect on August 31, 2010.

Traffic Growth Rate	Cost Factor	50-Yr PV, M of 2008$
	Delay	-$201.5
	Accident	-$11.0
2%	Fuel	-$122.0
	Pollution	-$9.5
	Total Impact	-$344.0
	Delay	-$953.2
	Accident	-$13.5
3%	Fuel	-$241.0
	Pollution	-$10.4
	Total Impact	-$1,218.0

Scenario 2 Results

As noted above, the second scenario refers back to the discussion of broken stone products that are hauled long distances by truck. The movement that CTR choose to evaluate (included in the 2007 Global Insight file) is based on a shipment of 266,511 annual tons moving between Montgomery County and Wilson County. This movement began on State Route 13 in Montgomery County and terminated in Wilson County on I40. For the purpose of this study, CTR only evaluated the movement from essentially downtown Clarksville to the border of downtown Nashville. Thus, the impacts occur in Clarksville and on I24.

It is significant that, whether the shipments occurred over 72, 144, or 216 days[45], a relatively small difference is found in the impacts if traffic is assumed to grow at one or two percent per year. Apparently, the capacity in the state and federal interstate highway system is not stressed to the point that reducing total traffic by one broken stone movement would produce any sizeable impact. But, if highway growth reached three percent per year, reducing overall traffic levels by this one movement produces more significant impacts. These data are shown in Table 24.

At a compound growth rate in total traffic of one percent, on a basis of 144 days and 13 trucks per hour, creates a present value of a $36.9 million dollar savings in social costs measured over 50 years. A forecast rate of two percent in highway growth yields a social cost savings of $84.7 million. At a rate of three percent, the social cost savings is $1.443 billion.

[45] The Global Insight data are reported as annual totals, thus we did not know the exact number of days required to complete the movement.

Table 24: Diversion of One Broken Stone Movement from Clarksville to Nashville

Social Discount Rate = 4.4%

Traffic Growth Rate	Cost Factor	50-Yr PV, M of 2008$ # Days/Year - # Daytime Trucks/Hour 72 days-26/hr	144 days-13/hr	216 days-9/hr
1%	Delay	-$20.5	-$20.5	-$21.4
	Accident	-$2.3	-$2.3	-$2.4
	Fuel	-$11.8	-$11.8	-$12.3
	Pollution	-$2.2	-$2.2	-$2.3
	Total Impact	-$36.8	-$36.9	-$38.4
2%	Delay	-$51.2	-$52.8	-$55.5
	Accident	-$2.8	-$2.8	-$2.9
	Fuel	-$26.5	-$26.7	-$27.8
	Pollution	-$2.4	-$2.4	-$2.5
	Total Impact	-$82.8	-$84.7	-$88.6
3%	Delay	-$1,196.4	-$1,384.6	-$1,507.1
	Accident	-$3.4	-$3.4	-$3.5
	Fuel	-$51.4	-$51.8	-$54.0
	Pollution	-$2.6	-$2.6	-$2.7
	Total Impact	-$1,253.8	-$1,442.5	-$1,567.3

CMAQ

The primary purpose of the CMAQ program is to clean the air. It provides a flexible funding source to state and local governments to fund transportation projects and programs to help meet the requirements of the Clean Air Act and its amendments. CMAQ monies are used to fund projects that reduce mobile source emissions in areas designated by the U.S. Environmental Protection Agency as in non-attainment or maintenance of national ambient air quality standards. Eligible activities include inter-modal freight transportation improvements among others. Intermodal partnerships between rail, truck, and marine carriers offer enhanced mobility by shifting traffic from congested highways to the private sector rail or marine shipping network, and in the process reduce air emissions by relieving congestion on the highways and shifting traffic to more fuel efficient transportation modes.

It is apparent that shifting commodities from truck transportation to the more fuel efficient barge transportation can produce significant air pollution benefits and possibly qualify certain projects for CMAQ funds. Shown in Table 23, construction of the general commodities terminals in Clarksville could produce air pollution improvements over the next 50 years equal to about $10 million assuming that traffic grows at two percent per year. However, the CTR highway capacity model is based on EPA's Mobile 6 model that was replaced by EPA's MOVES2010 in late 2009. In EPA studies, VOC emissions are lower when using MOVES2010 when compared to MOBILE6.2, while both NOx and Pm emissions are higher. It is certainly possible that air pollution benefits could be more significant if the model was updated to incorporate output from the MOVES2010 model.

Put in footnote EPA, "Policy Guidance on the Use of MOVES2010 for State Implementation Plan Development, Transportation Conformity, and other Purposes," December 2009.[46]

Summary and Conclusions

The goal of the study was to answer five questions, including, first, a determination of the potential for overland commodity movements in Tennessee to divert at least one leg of their journey to barge transportation. The second goal is to determine whether such diversions would be a monetary gain or loss to the state. Third, will Tennessee waterways become a conduit for container-on-barge traffic? Fourth, what are the externalities associated with the diversion, and, fifth, what are the policy alternatives for state and federal government to encourage the diversions? Last, the study presents some ideas concerning the development of a Waterways Advisory Council in Tennessee and a review of legislation in other states.

To accomplish the first task, the CTR was given access to the latest available transportation databases: the 2007 confidential rail waybill data, the 2008 USACE Waterborne Commerce Statistical Center database, and the 2007 Global Insight truck file. Viewing each file, it is apparent that the most likely candidate for modal diversion is the STCC2 group—nonmetallic ores and minerals, excluding fuels. While 62 percent of total truck traffic is classed as moving through the state, 84 percent of the stone grouping is inbound, outbound, or local to the state. If these movements are pared down to include only those that are greater than 150,000 tons, we are left with 16.1 million of tons of potentially divertible truck traffic. To shed further light on the subject, we mapped some of the larger movements, and this exercise further pushed us further toward broken stone as a divertible commodity. Certain stone commodities shipped long distances were identified in the interview process as most likely being non-polishing stone, 300-mesh material[47], and riprap. These are commodities that state DOTs regularly use in construction projects, making these agencies major consumers of transportation services in Tennessee and surrounding states. Likewise, the USACE shipped large tonnages of riprap 400 or so miles parallel to the Mississippi River in 2007 by truck. Again, these shipments were identified in the interview process.

Question two asks what (if any) subsidies will be necessary to accomplish the diversions. Concerning the coal movement, it is likely that TVA would save money by shifting to barge delivery of coal at the Kingston Plant. Concerning the question of potential subsidies to cause stone traffic to shift modes, CTR concludes that the Global Insight truck data do not give enough information to determine precisely the magnitude of any subsidies that might be required. CTR did, however, make some reasonable assumptions to estimate truck and barge rates for one movement from Montgomery

[46] EPA," Policy Guideline on the Use of MOVES2010 for State Implementation Plan Development, Transportation Conformity, and Other Purposes," EPA-420-B09-046, December 2009, page 4.

[47] The 300-mesh material is used in the manufacture of paint that is used to on road beds to mark lanes and for other purposes.,

County to Wilson County. This analysis suggested that for some movements barge carriage could be more competitive than shipment by truck given where the portable batch plant is sited.

Question three asks whether there is a significant probability that Tennessee waterways will be used to facilitate container-on-barge traffic. CTR finds that the likelihood of consistent and scheduled COB service in Tennessee, especially as related to Panama Canal expansion, is unlikely to occur. However, Tennessee could see some limited COB service, and Memphis could again see container traffic if the LIGTT terminal is constructed in New Orleans.

Question four asks if there will be positive externalities associated with the diversions. CTR used its highway capacity model to examine the environmental impacts given (1) construction of a general commodities terminal in Clarksville and (2) removal of one stone products movement between Montgomery County and Wilson County. At an assumed two percent traffic growth rate for truck and automobile traffic, the reduced truck traffic on the section of I24 between Clarksville and Nashville should result in about $344 million in environmental benefits over a 50 year period. From downtown Clarksville to Nashville, a reduction of one movement of stone products (266 thousand tons) is estimated to generate $84.7 million over 50 years. And since highway impacts are nonlinear, the shift of several movements to barge over the same stretch of roadbeds would significantly increase the environmental benefit of these modal shifts.

Question five asks what policy alternatives might be available to encourage the modal shifts. CTR feels that federal and state governments have some flexibility and leverage in moving highway traffic to the waterways in Tennessee because these two agencies are responsible for much of the stone products moving in the state. Further, the departments of transportation (or Cabinet in Kentucky) control the shipments moving from Tennessee quarries that produce materials needed in pavement mixes. We propose consideration of the following actions:

- TDOT could examine a wide variety of contracts to determine which of them incorporate stone shipments that could have moved by water transit. For a selection of each, the actual cost of truck transit should be compared against water transit to determine the savings or subsidy that would be required for the modal shift. Any subsidies could be weighed against the environmental benefits of the modal shift. This information could provide the basis for a program in which new contracts are examined for the potential for barge transportation use where appropriate.
- State government could advertise to alert Tennessee shippers as to the potential benefits of shipping by water. Our interviews demonstrated that lack of knowledge is a problem when making modal selections.
- TDOT and the USACE could make modal preference integral to the contract-making process. This would involve both agencies investigating planned construction projects to determine if water transportation is an option in the movement of stone or other products and, if so, requiring its use.
- Fourth, both agencies could investigate a multi-state corridor study to determine the benefits of using the navigable waterways as a transportation corridor. In examining the Global Insight data base, long-distance stone movements passing in, out, or through multiple states can only be understood or addressed when the state and federal governments have open communication

lines. Long truck hauls from Tennessee into Mississippi are most likely destined for MDOT construction projects, and it would have to be MDOT that addresses the transportation issue. TDOT would have no information about the movement. The study has shown that a multi-state consortium could lower the cost of operating all of the DOTs, make better use of the waterway infrastructure, improve air quality, lessen congestion, and make our highways safer.

- Fifth, the new generation of deck barges is not available for the carriers that now operate on the Tennessee and Cumberland Rivers. Assuming that either agency would plan to utilize such barges, some coordination between the government and the barge carriers would be necessary. The USACE and departments of transportation need to demonstrate that sufficient cargo would be projected to justify purchase of these barges.
- Sixth, the Waterways Advisory Council could work closely with the U.S. Army Corps of Engineers in support of their effort to maintain and modernize the inland river navigation infrastructure. An unreliable system is not conducive to large shifts in overland traffic to barge transportation.

Appendix A: Waterway Advisory Groups

The Creation of a Waterways Advisory Council

This review builds upon one of the aspects contained in "The Potential Contribution of Commercial Navigation to Freight Mobility in the Tennessee River Basin" project. One aspect of the study focuses on the "creation of a Water Transportation Advisory Group that would advise [Tennessee] Department of Transportation (TDOT) transportation planners in matters of needed upgrades to commercial barge transportation infrastructure." This short paper provides a review of potential members of the advisory board.

The following are the generalized guidelines laid out in Hanson Professional Services. Inc. Tennessee Assessment Study —Phase II, December 5, 2008. Hanson's Phase II study provides a guide for the types of individuals needed on the Water Transportation Advisory Group to advise and make recommendations to state policy makers concerning matters affecting water transportation in the state.

Hanson's Guidelines for the Water Transportation Advisory Group includes recommendations for the following seven members. The members could be appointed by the Commissioner of TDOT.

- Two members representing the state's public ports;
- Two members appointed at large from the private sector associated with the waterways industry;
- One member from the public at large who has technical experience in economic analyses, feasibility studies, port design and operations, or other similar knowledge of the maritime industry;
- One member from the Department of Economic and Community Development, and
- One member from other governmental agency

We propose to add four more members to the Water Transportation Advisory Group. Two more members appointed at large from the private sector should be added in order to represent each of the four significant waterways in Tennessee: Upper Tennessee, Lower and Middle Tennessee, Cumberland, and Mississippi. This precedent has already been set by Alabama and Arkansas (Appendix A). Additionally, two other members should be added from another governmental agency so that the Tennessee Valley Authority, the United States Army Corps of Engineers, and the United States Coast Guard can be represented in the 11-member Transportation Advisory Group.

Review of Other States' Advisory Boards

A review of other states that have established similar advisory groups was conducted. The specific legislative action that created each board has been identified, as well as the criteria for choosing each member.

Alabama

In Alabama HB 118 passed in March 2010, which allowed for the creation of a Waterways Advisory Board to represent the state's inland waterways. The board was created and outlined in Section 3 of the bill.

The bill allows the Alabama Department of Transportation's Transportation Director to create a Waterways Advisory Board, and to appoint members based on consultations with the Coalition of Alabama Waterways Associations (CAWA). The association members include the Tennessee-Tombigbee Waterway Authority, Coosa-Alabama River Improvement Association, Tri-rivers Area Development Association, Warrior-Tombigbee Development Association, and the Tennessee River Valley Association (Section 3 (a)). The nine member board consists of (Section 3 (a) 1-5):

- One representative from each of the associations representing the five major navigable waterways serving Alabama (Tennessee-Tombigbee Waterway, Alabama-Coosa Waterway, Chattahoochee-Apalachicola Waterway, Tennessee Waterway, and the Warrior-Tombigbee Waterway. The Gulf Intracoastal Waterway is not included.)
- One member from public port operations which have existing waterfront cargo handling facilities and which regularly employ the use of barge transportation
- One member from private port operations which serve the public, have existing waterfront cargo handling facilities, and which regularly employ the use of barge transportation
- The Executive Director, or his or her designee, of the Alabama State Port Authority
- One member at large from a business or industry associated with inland waterway navigation.

Arkansas

The Arkansas Waterways Commission was established by Act 242 of 1967, and its powers and duties were amended by Act 414 of 1973. The Enabling Laws of the Arkansas Waterways Commission also include Act 775 of 2007, A.C.A. §15-23-201 et seq. and A.C.A. §15-23-901 et seq. The Arkansas Waterways Commission is comprised of seven members appointed by the Governor, with the advice and consent of the Senate. The members serve seven-year, staggered terms. Five of the members represent five navigable stream basin areas of the state and two members serve "at large". The five representing the river basin areas are chosen from five lists of three, recommended through organized associations as qualified persons of demonstrated experience and interest in river development.

- Two "at large" representatives – One of these "at large" seats must be an economist.
- One representative from each of the five Arkansas Waterways (Ouachita River, Mississippi River, White River, Arkansas River, and Red River)

Currently, the two "at large" commissioners consist of:

- An individual who is a senior economist for the Arkansas Farm Bureau Federation, specializing in economic and tax policies affecting agriculture; who holds a master's degree in agricultural economics.
- A Senior Vice President of Operations at Allied Tube & Conduit, which brings in steel coils by barge; he also serves as a Director for the National Waterways Conference and the Pine Bluff/Jefferson County Port Authority.

The backgrounds of the five representatives from each of the waterways consist of:

- A business man native to the area;
- An individual who assisted in the creation and development of a Port along the Mississippi, has served as President of the local Chamber of Commerce, as well as a development company;
- An individual who has served as chairman of a County Levee Board, has been President of a Farm Bureau, and is co-owner of a large farm along the Red River;
- A native of the state who has retired from farming after 28 years, growing rice, wheat, corn, and soybeans along the White River; he holds a bachelor's degree in Agronomy, and
- An individual who has served as the executive director of the Little Rock Port Authority since 1999, and has a background in economic development and chamber of commerce service.

Kentucky

The Kentucky Water Transportation Advisory Boards was established by House Bill 28 as a new section of the Kentucky Revised Statues (KRS) Chapter 174 on March 24, 2010.

The Water Transportation Advisory Board shall be composed of seven members to be appointed as follows:

- Four members representing the Commonwealth's public river ports to be appointed by the Governor from a list of eight nominees supplied by the Kentucky Association of River ports;
- Two at-large members from the private sector associated with the waterways industry, and
- One member representing Kentuckians for Better Transportation to be appointed by the Governor from a list of three nominees supplied by that organization

Appendix B: STCC2-STCC4 Commodity Groups

Apparel or other finished textile products or knit apparel
- Apparel Belts
- Apparel Findings
- Apparel, NEC
- Canvas Products
- Caps Or Hats Or Hat Bodies
- Caps, hats Or Millinery
- Curtains Or Draperies
- Fur Goods
- Gloves ,Mittens Or Linings
- Leather Clothing
- Men's Or Boys Clothing
- Millinery
- Misc Apparel Or Accessories
- Misc Fabricated Textile Products
- Misc Finished Textile Goods
- Raincoats Or Other Rain Wear
- Robes Or Dressing Gowns
- Textile Bags
- Textile Housefurnishings
- Textile Prod, Pleated, etc.
- Women's Or Children's Clothing

Chemicals or allied products
- Adhesives
- Agricultural Chemicals
- Chemical Preparations, NEC
- Cosmetics, Perfumes, etc.
- Crude Prod Of Coal, gas, petroleum
- Cyclic Intermediates Or Dyes
- Drugs
- Explosives
- Fertilizers
- Gum Or Wood Chemicals
- Industrial Chemicals
- Industrial Gases
- Inorganic Pigments
- Misc Agricultural Chemicals
- Misc Chemical Products
- Misc Indus Inorganic Chemicals
- Misc Industrial Organic Chemicals
- Paints, Lacquers, etc.
- Plastic Mater Or Synthetic Fibres
- Potassium Or Sodium Compound
- Printing Ink
- Soap Or Other Detergents
- Specialty Cleaning Preparations
- Surface Active Agents

Clay, concrete, glass, or stone products
- Abrasive Products
- Abrasives, asbestos Products, etc.
- Asbestos Products
- Ceramic Floor Or Wall Tile
- Clay Brick Or Tile
- Clay, concrete, Glass Or Stone
- Concrete Products
- Concrete, Gypsum, Or Plaster
- Cut Stone Or Stone Products
- Flat Glass
- Gaskets Or Packing
- Glass Containers
- Glassware, Pressed Or Blown
- Gypsum Products
- Lime Or Lime Plaster
- Mineral Wool
- Misc Glassware, Blown Or Pressed
- Misc Nonmetallic Minerals
- Misc Pottery Products
- Misc Structural Clay Products
- Nonmetal Minerals, Processed
- Porcelain Electric Supplies
- Portland Cement
- Pottery Or Related Products
- Ready-mix Concrete, Wet
- Refractories
- Structural Clay Products
- Vitreous China Kitchen Articles
- Vitreous China Plumbing Fixtures

Coal
- Anthracite
- Bituminous Coal
- Bituminous Coal Or Lignite

Containers, carriers or devices, shipping, returned empty
- Semi-trailers Returned Empty

Crude petroleum, natural gas or gasoline
- Crude Petrol. Or Natural Gas
- Crude Petroleum
- Natural Gas
- Natural Gasoline

Drayage
- Air Freight Drayage from Airport
- Air Freight Drayage to Airport
- Rail Intermodal Drayage from Ramp
- Rail Intermodal Drayage to Ramp

Electrical machinery, equipment, or supplies
- Carbon Prod For Electric Uses
- Communication Equipment
- Current Carrying Wiring Equipment
- Electric Eq. For Internal Combustion Engine
- Electric Housewares Or Fans
- Electric Lamps
- Electric Lighting Or Wire Equipment
- Electric Measuring Instruments
- Electric Trans Or Distributors
- Electrical Equipment, NEC
- Electrical Transformers
- Electronic Components
- Electronic Tubes
- Household Appliances
- Household Cooking Equipment
- Household Laundry Equipment

Household Refrigerators
Household Vacuum Cleaners
Industrial Controls Or Parts
Industrial Electrical Equipment
Lighting Fixtures
Misc Electrical Industrial Equipment
Misc Electrical Machinery
Misc Electronic Components
Misc Household Appliances
Motors Or Generators
Noncurrent Wiring Devices
Phonograph Records
Primary Batteries
Radio Or TV Receiving Sets
Radio Or TV Transmitting Equipment
Sewing Machines Or Parts
Solid State Semiconductors
Storage Batteries Or Plates
Switchgear Or Switchboards
Telephone Or Telegraph Equipment
Welding Apparatus
X-ray Equipment

Fabricated metal products

Architectural Metal Work
Bolts, Nuts, Screws, etc.
Builders Or Cabinet Hardware
Cutlery, Hand Tools Or Hardware
Cutlery, not Electrical
Edge Or Hand Tools
Fabricated Metal Products, NEC
Fabricated Plate Products
Fabricated Structural Metal Products
Hand Saws Or Saw Blades
Heating Equip ,not Electrical
Metal Cans
Metal Doors, Sash, etc.
Metal Safes Or Vaults
Metal Sanitary Ware
Metal Shipping Containers
Metal Stampings
Misc Fabricated Metal Products
Misc Fabricated Wire Prod
Misc Fabricated Wire Products
Misc Hardware
Misc Metal Work
Plumbing Fixtures
Plumbing Or Heating Fixtures
Sheet Metal Products
Steel Springs
Valves Or Pipe Fittings

FAK Shipments

FAK Shipments

Farm products

Animal Specialties
Bulbs, roots Or Tubers
Citrus Fruits
Cotton, raw
Dairy Farm Products
Deciduous Fruits
Dry Ripe Vegetable Seeds
Farm Prod, NEC
Field Crops
Field Seeds
Fresh Fruits Or Tree Nuts
Fresh Vegetables
Grain
Horticultural Specialties
Leafy Fresh Vegetables
Live Poultry
Livestock
Livestock Or Livestock Prod
Misc Farm Products
Misc Fresh Fruits Or Tree Nuts
Misc Fresh Vegetables
Misc. Field Crops
Oil Kernels, Nuts Or Seeds
Poultry Eggs
Poultry Or Poultry Products
Tropical Fruits

Food and kindred products

Animal By-prod, inedible
Bakery Products
Beverages Or Flavor Extracts
Biscuits, Crackers Or Pretzels
Blended Or Prepared Flour
Bread Or Other Bakery Prod
Candy Or Other Confectionery
Canned Fruits, vegetables, etc.
Canned Or Cured Sea Foods
Canned Or Pres Food, Mixed
Canned Or Preserved Food
Canned Specialties
Cereal Preparations
Cheese Or Special Dairy Products
Condensed, Evaporated Or Dry Milk
Confectionery Or Related Prod
Cottonseed Oil Or By-prod
Creamery Butter
Dairy Products
Dehydrated Or Dried Fruit Or Vegs.
Distilled Or Blended Liquors
Dog, cat Or Other Pet Food, NEC
Dressed Poultry, Fresh
Dressed Poultry, Frozen
Flour Or Other Grain Mill Products
Frozen Fruit, Veg. Or Juice
Frozen Specialties
Grain Mill Products
Ice Cream Or Rel. Frozen Desserts
Ice, Natural Or Manufactured
Macaroni, spaghetti, etc.
Malt
Malt Liquors
Margarine ,shortening, etc.
Marine Fats Or Oils
Meat Or Poultry, Fresh Or Chilled

Meat Products
Meat, Fresh Frozen
Meat, Fresh Or Chilled
Milled Rice, Flour Or Meal
Misc Flavoring Extracts
Misc Food Preparations
Misc Food Preparations, NEC
Nut Or Veg. Oils Or By-products
Pickled Fruits Or Vegetables
Prepared Or Canned Feed
Processed Fish Products
Processed Milk
Processed Poultry Or Eggs
Roasted Or Instant Coffee
Soft Drinks Or Mineral Water
Soybean Oil Or By-products
Sugar Mill Prod Or By-prod
Sugar, Beet Or Cane
Sugar, Refined, Cane Or Beet
Wet Corn Milling Or Milo
Wine, Brandy Or Brandy Spirit

Forest products
Barks Or Gums, crude
Misc Forest Products

Fresh fish
Fish Hatcheries
Fresh Fish Or Marine Products
Fresh Fish Or Whale Products
Marine Products

Furniture or fixtures
Beds, dressers, chests, etc.
Bedsprings Or Mattresses
Benches, chairs, Stools
Buffets, China Closets, etc.
Cabinets Or Cases
Children's Furniture
Furniture Or Fixtures, NEC
Household Or Office Furn., NEC
Household Or Office Furniture
Lockers, Partitions Or Shelving
Metal Lockers, partitions, etc.
Misc Furniture Or Fixtures
Public Building Or Related Furniture
Sofas, Couches, etc.
Tables Or Desks
Venetian Blinds ,shades, etc.
Wood Lockers, partitions, etc.

Hazardous Materials
Flammable Liquids
Hazardous Materials
Other Regulated Materials Group A

Instruments, photog. goods, optical goods, watches, or clocks
Automatic Temperature Controls
Dental Equipment Or Supplies
Engrg., Lab Or Scientific Equipment
Measuring Or Controlling Equipment
Mech. Measuring Or Control Equipment
Medical Or Dental Instruments
Ophthalmic Or Opticians Goods
Optical Instruments Or Lenses
Orthopedic Or Prosthetic Supplies
Photographic Equip Or Supplies
Surgical Or Medical Instruments
Watches, Clocks, etc.

Leather or leather products
Boot Or Shoe Cut Stock
Industrial Leather Belting
Leather
Leather Footwear
Leather Gloves Or Mittens
Leather Goods, NEC
Leather House Slippers
Leather Luggage Or Handbags
Leather, Finished Or Tanned

Lumber or wood products, excluding furniture
Cork Products
Hand Tool Handles
Kitchen Cabinets, Wood
Lasts Or Related Products
Lumber Or Dimension Stock
Millwork Or Cabinetwork
Millwork Or Prefab Wood Products
Misc Sawmill Or Planing Mill
Misc Wood Products
Miscellaneous Wood Products
Plywood Or Veneer
Prefab Wood Buildings
Primary Forest Materials
Rattan Or Bamboo Ware
Sawmill Or Planning Mill Products
Scaffolding Equip Or Ladders
Structural Wood Prod, NEC
Treated Wood Products
Wood Cont. Or Box Shooks
Wood Prod, NEC
Wooden Containers
Wooden Ware Or Flatware

Machinery, excluding electrical
Accounting Or Calculating Equipment
Automatic Merchandising Machines
Ball Or Roller Bearings
Carburetors, Pistons, etc.
Commercial Laundry Equipment
Construction Machinery Or Equipment
Conveyors Or Parts
Electronic Data Proc Equipment
Elevators Or Escalators
Engines Or Turbines
Farm Machinery Or Equipment
Food Prod Machinery
General Industrial Machinery
Hoists, Industrial Cranes, etc.
Industrial Process Furnaces
Industrial Pumps
Industrial Trucks, etc.
Lawn Or Garden Equipment

Machine Tool Accessories
Machine Tools, Metal Cutting
Machine Tools, Metal Forming
Mech. Power Transmission Equipment
Metalworking Machinery
Mining Machinery Or Parts
Misc General Industrial
Misc Internal Combustion Engines
Misc Machinery Or Parts
Misc Office Machines
Misc Service Industry Machinery
Misc Special Industry Mach
Office Or Computing Machinery
Oil Field Machinery Or Equipment
Paper Industries Machinery
Printing Trades Machinery
Refrigeration Machinery
Scales Or Balances
Service Industry Machines
Special Dies, tools, Jigs, etc.
Special Industry Machinery
Steam Engines, Turbines, etc.
Textile Machinery Or Parts
Typewriters Or Parts
Ventilating Equipment
Woodworking Machinery

Mail And Express Traffic

Mail And Express Traffic

Metallic ores

Bauxite Or Other Alum Ores
Copper Ores
Gold Or Silver Ores
Iron Ores
Lead Or Zinc Ores
Manganese Ores
Metallic Ores
Misc Metal Ores
Zinc Ores

Miscellaneous freight shipments

Misc Freight Shipments

Miscellaneous products of manufacturing

Apparel Fasteners
Brooms, Brushes, etc.
Buttons
Carbon Paper Or Inked Ribbons
Children's Vehicle Or Parts, NEC
Costume Jewelry Or Novelties
Dolls Or Stuffed Toys
Feathers, Plumes, etc.
Furs, dressed Or Dyed
Games Or Toys
Jewelry, Precious Metal, etc.
Jewelry, Silverware, etc.
Linoleum Or Other Coverings
Manufactured Prod, NEC
Marking Devices
Matches
Misc Manufactured Products
Morticians Goods
Musical Instruments Or Parts
Office Or Art Materials
Pencils, Crayons, or Artists Materials
Pens Or Parts
Signs Or Advertising Displays
Silverware Or Plated Ware
Sporting Or Athletic Goods
Toys, Amusement, Athletic Equipment

Nonmetallic ores, minerals, excluding fuels

Broken Stone Or Riprap
Chem. Or Fertilizer Minerals
Chem. Or Fertilizer Minerals, Crude
Clay Ceramic Or Refrac. Minerals
Dimension Stone, Quarry
Dimension Stone, quarry
Gravel Or Sand
Misc Nonmetallic Minerals
Misc Nonmetallic Minerals, NEC

Ordnance or accessories

Ammo Or Related Parts, NEC
Small Arms Ammo, 30mm Or Less
Small Arms, 30mm Or Less
Tracked Combat Vehicles Or Parts

Petroleum or coal products

Asphalt Coatings Or Felt
Asphalt Paving Blocks Or Mix
Liquefied Gases, coal Or Petroleum
Misc Coal Or Petroleum Products
Paving Or Roofing Materials
Petroleum Refining Products
Prod Of Petroleum Refining

Primary metal products

Aluminum Or Alloy Basic Shapes
Aluminum Or Alloy Castings
Blast Furnace Or Coke
Copper Or Alloy Basic Shapes
Copper Or Alloy Castings
Electrometallurgical Products
Iron Or Steel Castings
Iron Or Steel Forgings
Misc Nonferrous Basic Shapes
Misc Nonferrous Castings
Misc Prim Nonferrous Smelter Products
Misc Primary Metal Products
Nonferrous Primary Smelter Products
Nonferrous Metal Basic Shapes
Nonferrous Metal Castings
Nonferrous Metal Forgings
Nonferrous Wire
Primary Aluminum Smelter Products
Primary Copper Smelter Products
Primary Iron Or Steel Products
Primary Lead Smelter Products
Primary Metal Products, NEC
Primary Zinc Smelter Products
Steel Mill Products
Steel Wire, Nails Or Spikes

Printed matter
- Blankbook, Loose Leaf Binder
- Books
- Greeting Cards, Seals, etc.
- Manifold Business Forms
- Misc Printed Matter
- Newspapers
- Periodicals
- Svc Indus For Print Trades

Pulp, paper, or allied products
- Containers Or Boxes, paper
- Converted Paper Or Paperboard Products
- Die-cut Paper Or Paperboard Products
- Envelopes
- Fiber, Paper Or Pulpboard
- Fibre Cans, Drums Or Tubes
- Misc Converted Paper Products
- Paper
- Paper Bags
- Paper Or Building Board
- Pressed Or Molded Pulp Goods
- Pulp Or Pulp Mill Products
- Sanitary Food Containers
- Sanitary Paper Products
- Wallpaper

Rubber or miscellaneous plastics products
- Misc Fabricated Products
- Misc Plastic Products
- Reclaimed Rubber
- Rub Or Plastic Hose Or Belting
- Rubber Or Plastic Footwear
- Tires Or Inner Tubes

Textile mill products
- Carpets, Mats Or Rugs, NEC
- Coated Or Imprinted Fabric
- Cord Or Fabrics, industrial
- Cordage Or Twine
- Cotton Broad-woven Fabrics
- Felt Goods
- Floor Coverings
- Knit Fabrics
- Lace Goods
- Man-made Or Glass Woven Fibre
- Man-made Or Silk Woven Fibre
- Misc Textile Goods
- Narrow Fabrics
- Paddings, Upholstery Fill ,etc
- Silk-woven Fabrics
- Textile Goods, NEC
- Textile Waste, Processed
- Thread
- Thread Or Yarn
- Tufted Carpets, rugs Or Mats
- Wool Broad-woven Fabrics
- Wool Or Mohair
- Woven Carpets ,mats Or Rugs
- Yarn

Tobacco products, excluding insecticides
- Chewing Or Smoking Tobacco
- Cigarettes
- Cigars
- Stemmed Or Redried Tobacco

Transportation equipment
- Aircraft
- Aircraft Or Missile Engines
- Aircraft Or Parts
- Aircraft Propellers Or Parts
- Locomotives Or Parts
- Misc Aircraft Parts
- Misc Transportation Equipment
- Missile Or Space Vehicle Parts
- Motor Bus Or Truck Bodies
- Motor Vehicle Or Equipment
- Motor Vehicle Parts Or Accessories
- Motor Vehicles
- Motorcycles, Bicycles Or Parts
- Railroad Cars
- Railroad Equipment
- Ships Or Boats
- Trailer Coaches
- Transportation Equipment, NEC
- Truck Trailers

Warehouse & Distribution Center
- Warehouse & Distribution Center

Waste or scrap materials not identified by producing industry
- Ashes
- Chemical Or Petroleum Waste
- Metal Scrap Or Tailings
- Misc Waste Or Scrap
- Paper Waste Or Scrap
- Rubber Or Plastic Scrap
- Textile Scrap Or Sweepings
- Waste Or Scrap

Waste Other Regulated Materials Group E
- Waste Other Regulated Materials Group E

Appendix C: Alternative Calculations of Tons Per Truck

The following table of tons per truck is taken from "Freight Impacts on Ohio's Roadway," Cambridge Systematics, Inc., March 2002.

Table 1.3 Ohio Tonnage to Truck Conversion Factors (Tons per Truck)

		Distance Class				
Two-Digit STCC Codes	Two-Digit STCC Commodity Name	Local (<50 Miles)	Short (50 to 100 Miles)	Short-Medium (100 to 200 Miles)	Long-Medium (200 to 500 Miles)	Long (>500 Miles)
1	Farm products	12.04	18.37	19.10	18.71	17.67
8	Forest products	13.36	11.64	13.27	13.27	13.27
9	Fresh fish or marine products	8.20	8.13	14.42	15.89	16.11
10	Metallic ores	16.98	18.81	25.77	25.77	25.77
11	Coal	16.98	18.81	25.77	25.77	25.77
13	Crude petroleum or natural gas	14.43	19.58	17.84	17.84	17.84
14	Nonmetallic minerals	16.98	18.81	25.77	25.77	25.77
19	Ordnance or accessories	7.05	4.42	11.47	9.84	11.30
20	Food or kindred products	8.20	8.13	14.42	15.89	16.11
21	Tobacco products	11.50	16.25	16.03	11.47	15.96
22	Textile mill products	1.34	3.57	18.18	18.16	17.48
23	Apparel or related products	1.34	3.57	18.18	18.16	17.48
24	Lumber or wood products	10.33	12.35	17.50	17.61	17.83
25	Furniture or fixtures	2.92	3.25	11.02	11.26	11.38
26	Pulp, paper, or allied products	4.07	7.67	15.66	15.17	14.59
27	Printed matter	4.07	7.67	15.66	15.17	14.59
28	Chemicals or allied products	5.18	15.39	19.55	19.25	19.25
29	Petroleum or coal products	14.43	19.58	17.84	17.84	17.84
30	Rubber or misc. plastics	7.05	4.42	11.47	9.84	11.30
31	Leather or leather products	1.34	3.57	18.18	18.16	17.48
32	Clay, concrete, glass, or stone	10.69	14.47	18.53	18.63	18.81
33	Primary metal products	11.82	14.73	19.96	20.14	20.13
34	Fabricated metal products	4.00	11.33	14.49	14.49	14.49
35	Machinery	6.97	12.55	17.42	17.21	17.21
36	Electrical equipment	4.05	7.42	14.81	14.62	14.62
37	Transportation equipment	2.48	14.12	17.21	16.92	14.18
38	Instruments, photo equipment, optical equipment	6.97	12.55	17.42	17.21	17.21
39	Misc. manufacturing products	5.48	5.40	11.63	13.04	14.23
50	Drayage, warehousing, distribution	7.05	9.67	14.85	14.98	14.93

Another table of tons per truck is from "Estimating Statewide Truck Trips Using Commodity Flows and Input-Output Coefficients," by Jose A. Sorratini in the *Journal Of Transportation And Statistics, April 2000.*

TABLE 1 Selected Economic Sectors

SIC–STCC[1]	Sector	Tons per truck[2]
01	Farm products	24
08	Forest products	13
09[a]	Fresh fish and other marine products	06
10[a]	Metallic ores	24
13[a]	Crude petroleum, natural gas, and gasoline	14
14	Nonmetallic minerals	19
19	Ordinances and accessories	24
20	Food and kindred products	18
21	Tobacco products, excluding insecticides	05
22	Textile mill products	05
23	Apparel and other finished textile products	03
24	Lumber and wood products, excluding furniture	15
25	Furniture and fixtures	03
26	Pulp, paper, and allied products	16
27[a]	Printed matter	09
28	Chemicals and allied products	22
29	Petroleum and coal products	19
30	Rubber and miscellaneous plastic products	04
31	Leather and leather products	03
32	Clay, concrete, glass, and stone products	23
33	Primary metal products	19
34	Fabricated metal products	24
35	Machinery, excluding electrical	09
36	Electrical machinery, equipments, and supplies	08
37	Transportation equipment	12
38[a]	Instruments, photographic and optical goods	05
39	Miscellaneous products of manufacturing	02
40	Waste and scrap materials	16

[1] SIC = Standard Industrial Classification
STCC = Standard Transportation Commodity Classification
[2] Source: TRANSEARCH database (TRANSEARCH 1996)
[a] Sectors with production tons from the TRANSEARCH database (TRANSEARCH 1996)